THE DESCRIPTION and USE Of that moſt Excellent INVENTION Commonly call'd *MERCATOR*'s-*CHART*;

WITH
Some Obſervations, uſeful for the better Underſtanding the Nature thereof:

To which is Added
The Deſcription of a New SCALE, whereby Diſtances on a given Courſe may be Meaſured, or Laid Off, at One Extent of a Pair of Compaſſes; which renders this *Chart* as Eaſy in Practice as the *Plain Chart*: Alſo a *Letter* to Dr. *Halley*, concerning the *Globular Chart*.

By THOMAS HASELDEN;
Late Teacher *of the* Mathematicks, *to his* Majeſty's-Volunteers, *in the* Royal Navy.

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BRITISH MUSEUM

To the Celebrated
Dr. *EDMUND HALLEY*,
Regius Profeſſor of *Aſtronomy*, &c.

SIR,

THE *Occaſion of my troubling you with this* Epiſtle, *and the* Publick *with the following little Piece, is this: About Two Years ſince a certain Perſon or Perſons having caus'd to be engrav'd a* Curvilineal Sea-Chart, *and either their Importunity, or Indigence, or what other Motive I know not, having prevail'd upon your good Nature, to give them a Recommendatory Certificate to the ſaid* Performance; *they have thereupon taken ſuch Liberties as I dare ſay, when I ſhall have laid them before you* *, *you will not be well pleas'd with: And ſince 'tis very reaſonable to ſuppoſe, that a Gentleman of your* Learning *is taken up with the Contemplation of the* Sublimer Parts

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* I have been with moſt of the *Undertakers* to buy this *Globular Chart*, and they aſſert, That it far excels all others, and ground their Aſſertion (tho' it don't appear, by your Certificate, that they have the leaſt Reaſon ſo to do) on your Approbation. This is their Argument when all others fail, without which they would have found but few Encouragers.

of Knowledge, *and may therefore be a Stranger to what paſſes among the lower Claſs of Mankind, I think it the Duty of every Man, who has a real Concern for the* Truth, *when he hears ſo great a* Character *as your's, proſtituted to ſo vile a Purpoſe, as that of impoſing on the* Publick, *to let you know it. 'Tis upon this Principle, and from a Regard we ought to have for ſo brave and uſeful a Sett of Men as the* Sailors *are, that I preſume to ſet before you ſome of the Artifices that have been made uſe of to uſher, if poſſible, this* New Performance *(as 'tis call'd) into the* World.

And Firſt, becauſe the Mercator's-Chart *is that which has ſtood the Teſt of many Years, and is now generally receiv'd as the beſt Way of repreſenting the Surface of the* Terraqueous Globe, *by all who know the Excellency thereof: This* Chart, *the* Authors *of this* Globular Performance, *like crafty* Politicians, *who know the Neceſſity of getting rid of a* Formidable Enemy, *before they can ſecure themſelves, have repreſented not only as* Puzling *and* Difficult, *but* Falſe, *and that too One Mile in Six, as my ſelf have heard them aſſert in private Converſation. Here, Sir, I cannot forbear Obſerving with what* Superlative Inſolence *you are treated by thoſe Men to whom you have been ſo kind; certainly if they had known any Blemiſh in your* Character, *they ought in Gratitude induſtriouſly to have conceal'd it: but, ſince that is as clear as the Light, for them to ſay, that what you have condeſcended profeſſedly to write on, and to publiſh to the whole learned World, in the Tranſactions of the* Royal Society; *that this Performance of yours has been about a Matter ſo notoriouſly Falſe and Abſurd, is a Piece of Impudence more than common.*

They have other Objections againſt the Mercator's Chart, *as that it is built on the falſe* Hypotheſis *of the* Globes *being a* Cylinder, *that it is a World without Ends, (Poles I ſuppoſe they mean) that the ſame Proportion does not hold throughout, that it repreſents Places bigger than they are upon the* Globe, *that it is made up of a* Number *of* Proportional Falſehoods, *tho' at the ſame time (a thing to be wondered at) they have ſo much Modeſty left, as to acknowledge that* Truth *may be gathered from it, although with Difficulty; and many more ſuch trivial Things, which are eaſily refuted: But ſince* *the main Queſtion that relates to the* Mercator's, *or indeed to any other* Chart, *is whether it will ſhew by a ready Method, the true* Bearings *and* Diſtances of Places *when laid down, according to their true* Latitudes *and* Longitudes ; *if the* Mercator's-Chart *can do this*, (*as all that know it will allow it does*) *then all the* Objections *which theſe Men can make will be of no Force*: *And indeed, had there been any* Material Objections *againſt the* Mercator's-Chart, *no doubt but that vaſt Depth of Thought whereby you ſo happily penetrate into the profoundeſt* Secrets of Nature, *would long ſince have diſcovered them. But ſince you have not ſo much as hinted at the leaſt* Objection *againſt the* Mercator's-Chart, *but on the contrary, have ſaid very handſome Things of it, and greatly improv'd its* Theory; *'Tis no Matter what's ſaid by ignorant and partial Men.*

Having thus briefly repreſented what has been ſaid of the Mercator's-Chart, *I ſhall next obſerve to you certain Particulars in the large Sheet of* printed Propoſals, *for* Printing by Subſcription, a compleat Sea Atlas *according to the* Globular Projection ; *which is ſaid firſt to be warranted by his Majeſty's Letters Patents under the Great Seal of* Great Britain ; *this certainly is deſigned to give Reputation to the Performance, but how far it may Anſwer that End, when the Thing for which it is obtained is good for little, is not my Buſineſs at preſent to examine* ; *what I ſhall here obſerve to you is, that this* Globular Projection *is no new Invention, as its* new Author *in his printed Directions of its Uſe, would fain make the World believe*; *where, he himſelf ſuppoſes the World, making this Objection*, viz. that 'tis no new Thing, there being Maps of the *World*, *Europe*, *Aſia*, &c. now in Print, with Curvilineal Meridians, Parallels, *&c. to which he anſwers*, that it is ſo ; *but ſays*, they are done from the Stereographick Projection of the *Sphere*, which is only a Branch of *Perſpective*, &c.

But whoever will look into Blundevile's *Treatiſe of* Maps *and* Charts, *printed in* 1621, *will there find a Deſcription of a* Chart *made by* Mercator *in the Year* 1554, *after another manner, which I will here ſet down.*

Let the Propoſition be, to conſtruct a Chart, *bounded by the Latitudes of 30 and 85 Deg. North, and having 60 Deg. Difference of Longitude.*

Firſt, Blundevile *directs to draw a Right-line* AB, *thro' the midſt of the* Chart *for a Meridian, and from* B *to lay off 12 Equal Parts, each being 5 Deg. of Latitude to* A *the Pole, on which as a Center, he draws the Parallels of Latitude* 30.30, 35.35. 40.40, &c. *that done, he directs to lay off on the upper and lower Parallel the Degrees of Longitude, according to the Proportion they there bear to a Degree of the Meridian, and thro' the correſponding Points in theſe two Parallels and the Pole, to draw Circles for the other Meridians: But here I conceive* Blundevile *has miſtaken* Mercator*'s Method, for if this* Chart *be made to 75 Deg. of Latitude, and 60 Deg. of Longitude, then the Meridian* ACDEF, *muſt paſs thro' the points* A, C *and* F, *but if it be made only to 70 Deg. of Latitude, then that Meridian muſt paſs thro'* A, D *and* F; *and if the* Chart *be made but to 65 Deg. of Latitude, then the ſaid Meridian muſt paſs thro'* A, E *and* F, &c. *from whence 'tis evident, that the Meridian* AF, *according to* Blundevile*'s own Conſtruction, muſt paſs thro' all the points* C, D, E, &c. *and conſequently will not be Circles but ſome other Curves, from whence it follows, that if the Meridians are made Circles, then the parts af the Parallels* Cc, Dd, Ee, *&c. will not have the ſame Proportion among themſelves as on the* Globe: *which Error being ſo eaſy, both to be perceived and avoided; I am ſatisfied that* Mercator*'s Curves were not of the circular Kind, tho'* Blundevile *in a ſuperficial View might take them to be ſuch.*

Here then is a Curve-lin'd Chart, *made 167 Years ago, which (contrary to what our Author aſſerts) is not only different from the* Stereographick Projection, *but the very ſame as the* Globular Chart. *Now, that any Perſon or Perſons, ſhould ſollicit for a Patent for this old* Chart *under a new Name, and ply the* Nobility, Gentry, *and* Commonality, *for Subſcriptions, to a Thing, which, as I ſhall ſhew a* *little further, will lead the* Mariner *out of his Way* 20 *Deg. in* 40. *I appeal to you,* Sir, *if this be any Thing leſs, than impoſing on the Three Eſtates of this Kingdom?*

We are told in the next Place, That there will be a General Treatiſe of Navigation *prefix'd, wherein,* &c. *and that the Whole is ſubmitted to your Inſpection and Approbation,* &c. *I don't in the leaſt doubt,* Sir, *as the Author denies the Truth of* Mercator's Chart, *and conſequently of* Mercator's Sailing, and ſays moreover, that by *Mercator's Projection* only, the Learner can never know properly, how to apply his *Geometrical* and *Trigonometrical Calculations* upon theſe *Charts,* to the Convex Superficies of the *Terreſtrial Globe, but you will take Care that the* Calculus *in this* General Treatiſe *be adapted to his Performance, and ſince moſt of the* Triangles *on this* Chart *conſiſt of a* Great Circle, *a* Small Circle, *and a* Spiral Line, *the World will certainly expect a* New Trigonometry, *quite different both from* Plane *and* Spherical; *which indeed will be a very curious Piece, and, if well done, will no doubt paſs your Approbation. But if on the contrary, he ſhould give us no other* Calculus *than the* Mercatorian, *in a Performance that would ſeem to ſuperſede it; This Practice, I am ſatisfyed, you and all ingenious Men will treat with Scorn and Contempt, as it deſerves.*

The next Thing we are told is, that the beſt Charts which have yet been publiſh'd are, from a Projection APPARENTLY Falſe and Abſurd, ſaid to repreſent the Globe, and yet no ways agreeing to the Nature thereof, which renders the ſetting off a Ships Way thereupon, very difficult and in ſome Caſes Impracticable.

I preſume the Mercator's Chart *is here intended, becauſe of the Words* Beſt Chart, *which the* Mercator's *has always been thought to be, and becauſe of theſe Words,* ſaid to repreſent the Globe, *which I think the* Plain Chart *was never ſaid to do; it muſt then*

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be the Mercator's Chart *that is here ſaid to be attended with Difficulty, Impracticability, and* APPARENT *Falſities. As to the Difficulty that attends* Mercator's Chart, *(if there be any) it is in the Meaſuring and Laying off Diſtances; but this, I hope, I have intirely remov'd by contriving a* Scale, *(a* Specimen *of which, if you pleaſe to give your ſelf the* Trouble, *you may ſee at the latter End of this Piece, by the help of which any* Diſtance, *upon a given* Rhumb *may be either meaſur'd or laid off at one Extent. And ſince this renders the* Mercator's Chart *as eaſy in Practice as the* Plain; *it will, I believe, be look'd upon as no mean Improvement of that moſt excellent Invention: It is farther objected, that there are ſome* Caſes *wherein 'tis* Impracticable *to ſet off a Ship's Way on the* Mercator's-Chart. *If the Propoſers would be pleas'd here to conſider, they will find but one of thoſe Caſes, which are uſually propos'd in* Mercator's Sailing, *Impracticable, viz. when one Latit. Diſtance, and Diff. of Longitude is given; which is the Caſe propos'd by you in the* Tranſactions, N°. 219; *and what I ſuppoſe the Propoſers here mean. This, I muſt own, has not yet been ſolv'd by any that I know of; but then, as it is a Caſe that has not hitherto happen'd, nor perhaps ever will happen at Sea, tho' the Solution of it may open ſome further Light into the Myſteries of* Geometry *(as you there take Notice) yet I don't perceive that the* Mariner *would be at all benefited thereby, and therefore is of no great Conſequence to them, ſhould it remain unſolv'd. Here, Sir, is another flagrant Inſtance of the Propoſers fair and ingeneuous Dealing with the* Publick, *and of their Reſpect to the Memory of the Famous Mr.* Wright, *to pretend that there are ſome Caſes, where there is but one, and that too of no Conſequence in the Practice of* Navigation. *But, our Author, ſtill the better to colour his Deſign, in his* Printed Directions *has offer'd at the Solution of this Problem, by the* Globular Chart, *and, for his Example, has prudently taken no greater a Diſtance than* 40 *Leagues: But let him ſuppoſe the Diſtance* 800 *or* 1000 *Leagues, and then try if it can be done any more by his* Chart *than by* Numbers.

In the laſt Place, the Mercator*'s*-Chart *is ſaid to be* APPARENTLY *falſe. Yet, Sir, if a Thing be* REALLY *true, I believe you will readily grant that its falſe Appearance will ſignifie nothing; ſuppoſe for Inſtance,* a Sailor *has good Silver in his Pocket, and the Buldge-Water in a tight Ship ſhould change the Colour, and make it* apparently falſe, *or* bad, *does it from hence follow that 'tis really ſo?*

Thus the Lines *of* Chords, Sines, Tangents, Secants, *&c. are all* apparently *falſe, becauſe the Degrees of the* Circle, *which are equal among themſelves, are on thoſe Lines repreſented unequal, that is,* apparently falſe. *But if any one, who pretends to Skill in the* Mathematicks, *ſhould, therefore aſſert, that they were really* falſe, *and of no Uſe, would not all the World conclude that either He did not underſtand theſe* Lines, *or had ſome Siniſter End to ſerve? Even ſo it is with* Mercator*'s*-Chart, *which muſt be own'd, is* apparently *falſe; but, I dare ſay, there's not a Man to be found, (unleſs in the Number of theſe Propoſers) that would expoſe his Ignorance ſo much, as to ſay it is* really *ſo. This* Chart *then is a true* Chart, *i. e. will ſhew the true Bearings and Diſtances of Places, when they are laid down in their true Latitudes, and Longitudes. This the Propoſers ſeem'd to be appriz'd of, and therefore have made Uſe of the ambiguous Term* APPARENTLY.

I ſhall in the next place, Sir, take Notice of what is advanc'd in the foremention'd Propoſals, concerning the Globular Performance *it ſelf, where, I queſtion not, the ſame Contrivance and Sophiſtry will appear to you which run thro' the Whole.*

Firſt then, it is pretended that the Projections *are (like the* Earth *it ſelf) truly* Globular, *with inclining Meridians, equi-diſtant Parallels,* &c. *agreeing to all the Definitions of the* Globe.

Now, that a Thing may be truly Globular, *and agreeable to the Definitions of the* Globe, *it muſt have theſe Properties,* viz. firſt, *Length, Breadth, and Thickneſs*; ſecondly, *every Point in its* Surface *muſt be equi-diſtant from ſome certain Point*; thirdly, *its Meridians muſt be, not only* Inclining, *but perfect* Circles *too*;

on the contrary, ſince this Globular Projection *is done on a Plain, it will want the Dimenſion of Thickneſs: For the ſame Reaſon, every Point in its Surface cannot be equi-diſtant from ſome certain Point, and ſo will not agree to all the Definitions of the* Globe; *however, being the Words* GLOBE *and* GLOBULAR *ſound Great in the Ears of the Vulgar, and make them imagine there muſt be ſomething Extraordinary, where-ever they hear them: our Author has thought fit to make choice of them (as the* Aſtrologer *does his Schemes and uncouth Words and Phraſes) to gull the unwary part of Mankind. But this* Globular Chart *does not only not agree to thoſe* Definitions *of the* Globe, *that reſpect it's Dimenſions, and the Diſtance of the Surface from it's Center, but alſo differs from the Definition of the Meridians, which are* PERFECT CIRCLES; *for the Meridians of this* Globular Chart *are not Perfect Circles, and conſequently do not agree to the Definition of a Meridian; and this the Author very well knew, and accordingly proceeds in the ſame Vein of Shuffling, and ſays they are* INCLINING.

I cannot but think it would have been much more for the Reputation of Mr. Henry Wilſon, *the pretended Author of this* Globular Chart, *if he had continued to recommend (as I can ſhew under his own Hand, he not long ſince did) the* Mercator's *as the* ONLY CHART, *and had not in ſo prevaricating a Manner endeavour'd to ſet both the one and the other in a falſe Light; for by ſo doing, he had acted the honeſter Part, and avoided the juſt Cenſure of the knowing World.*

I might have Diſſected theſe Propoſals, *and ſhewn their Artful Contrivance, in a more particular Manner, but let it Suffice, at preſent, to have laid before you ſuch palpable Inſtances of the bold Attempts, and mean Shifts of theſe Men, in a Paper, where your great Name, (which lateſt Poſterity will Eſteem as Sacred) is Writ in Capital Letters, to recommend a* Performance *falſe in the main Points of Practice; which are, the finding the Courſe and Diſtance from one Place to another, as I ſhall here prove. And firſt, as to the Courſe, 'tis a known Propoſition, that the* Rhumb Lines, *(by which I un-*

derſtand all but North, South, Eaſt and Weſt) do, by certain Revolutions, approach the Poles; *but though theſe Revolutions are Infinite in Number, yet can the* Rhumb Lines *never fall* into *the* Poles; *from whence it follows, that Two like* Rhumb-Lines, *as Two North-Eaſts, for Inſtance, will approximate each other; ſo that a Line drawn Parallel to any given* Rhumb-Line *on the* Globe, *or any Projection thereof, where the* Rhumbs *are* Curves, *at any Diſtance, cannot be a* Rhumb *of the ſame Denomination with the given* Rhumb: *And ſince in the Inſtructions for the Uſe of the* Globular Chart, *we are directed to draw a Parallel, ſuppoſing to a NE. by N. for a NE. by N. 'tis plain that this* Globular-Chart *is falſe in the Practice of finding the* Courſe, *that leads from one Place to another.*

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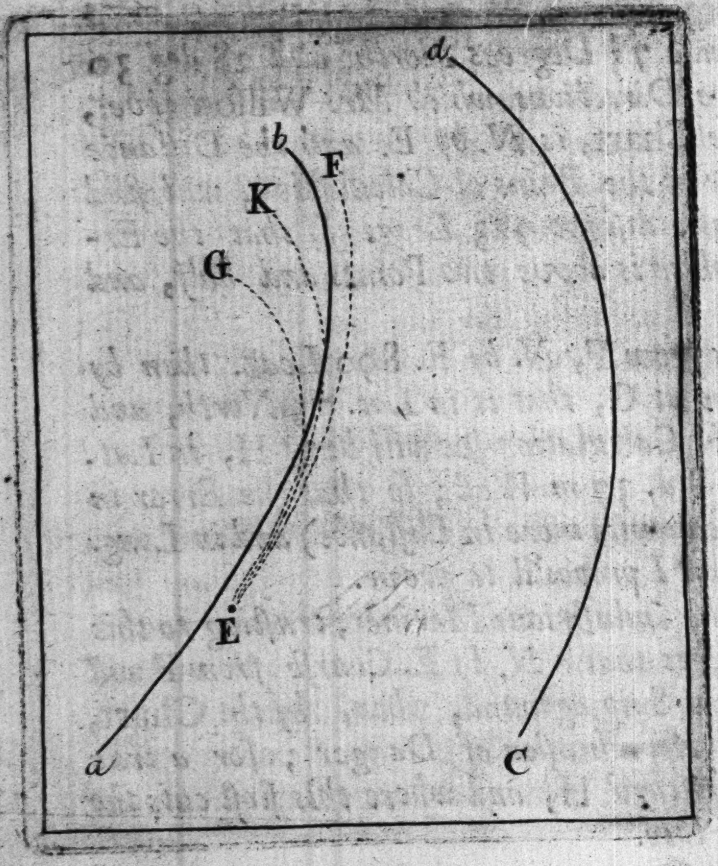
But that it may ſtill farther appear how falſe it is in this Point, I will ſuppoſe a Ship bound from the Weſtern Iſland F, *in the following* Chart, *lying in Lat. 39 deg. 29 min. N. and Long. 32 deg. Weſt from* London, *to* G *in Latitude 75 Degrees North, and 28 deg. 30 min. E. Now, according to the Directions which Mr.* Wilſon *gives, the Courſe from* F *to* G, *by the* Chart, *is N. by E. and the Diſtance 890 Leag. but who ever will be at the Pains of Calculation, will find it to be North 39 d. 34 m. Eaſt, diſtant 923 Leag. ſo that the Error in Courſe is 28 d. 19 m. which is above two Points and half, and in Diſtance 33 Leagues.*

Again, Suppoſe a Ship ſails from F, *N. by E. 890 Leag. then by the* Globular Chart *ſhe will be at* G, *that is in Lat. 75 North, and Long. 28 d. 30 m. Eaſt, but by Calculation ſhe will be at* H, *in Lat. 83 d. 30 m. North, and Long. 8 d. 37 m. Weſt; ſo that the Error in Latit. is 8 d. 30 m. (and conſequently more in Diſtance) and in Long. 37 d. 07 m. which is more than I propos'd to prove.*

Hence it will follow, that the Induſtrious Mariner, truſting to this Globular Chart, *by which he ſees that a N. by E. Courſe from* F *will carry him ſafe to* G, *will run his Ship aground, when, by the* Chart, *he ought not to have the leaſt Apprehenſion of Danger; for a true N. by E. Line from* F *will paſs thro'* H, *and where this firſt cuts the Land, that will be the fatal Place.*

Theſe Things being throughly conſider'd, 'tis matter of the higheſt Aſtoniſhment to me, that there ſhould be found any one ſo very Mercenary, as to propoſe this Chart *for Uſe in* Navigation, *where the Welfare of his Country is ſo much concern'd.*

But the Author *perhaps will object, that it will do well enough in ſhort Voyages: To which we anſwer, ſo will the* Plain Chart, *therefore in that Reſpect the Plain one is the better of the two, becauſe the Eaſier. He may further object, that he gives a* more exact *Rule for finding the Bearings of Places, or Pricking off a given Courſe, but then he immediately ſubjoyns* that the Trouble of it is not neceſſary, and ſays the former Rule (*which is that I have made uſe of to Solve the Queſtion above*) is ſufficiently exact to find the Rhumb to leſs than half a quarter of a Point of the Compaſs, in all Caſes in Common Practice. *But, that this is falſe, I have, if I miſtake not,* ſufficiently *prov'd: And, to ſhew further, that this* Globular Chart *is no ways uſeful at Sea, I will endeavour to make it appear that what he calls his* more exact Rule *is alſo falſe; in Order to which, ſuppoſe* a b *and* c d, *two North North-Eaſt Lines, and a Ship from* E *would ſail North North-Eaſt: Here the Author directs,* firſt, from *E,* to draw a Line Parallel to *a b* which lies on the one Side of *E; let this Parallel be* EF, and from *E,* a Parallel to *c d* lying on the other Side



Side of E, *let this be* E g; *and then tells us* we muſt obſerve the Difference between the Curves *EG and EF*, which, *he ſays*, by allowing PROPORTIONALLY we ſhall find where between them the true Rhumb will fall: *Now, I would have a true North North-Eaſt Line from* E, *but how muſt I allow* PROPORTIONALLY? *Muſt I deſcribe, with my Hand, by Gueſs, the Curve* EK, *that ſhall lie in the Middle between* EG *and* EF? *If this be what he means by* PROPORTIONALLY, *then* EK *muſt be a North North-Eaſt Line; and a North North-Eaſt Line from* E *will interſect a North North-Eaſt Line from* A, *which is abſurd.*

If he will not allow this to be his Meaning, how then ſhall we determine the Senſe of the Word PROPORTIONALLY, *and conſequently deſcribe a true North North-Eaſt Line from* E? I *believe no Man can tell: For, indeed, the Whole is a Heap of unintelligible Stuff; a mere Jargon of Words.*

Thus having prov'd the Globular Projection *ſo notoriouſly Falſe, in the Practice of finding both the Courſe and Diſtance; I ſhall now obſerve that 'tis Deficient on many other Accounts: As firſt, becauſe thereon cannot be repreſented the Whole Navigable World at one General View; which is certainly very neceſſary, and therefore is the firſt in every* Atlas, *but which we muſt by no means expect in this new One, unleſs the Propoſers are ſo kind as to give us one from ſome other* Projection, *and then their* Atlas *will be compos'd of a mixture of* Charts *of different* Projections; *but this will be contrary to their Propoſals, according to which, we are not to expect any Thing, no not ſo much as the ſingle Draught of a Harbour, but what ſhall be* TRULY GLOBULAR.

Another Deficiency in this Way of repreſenting the Surface of the Globe is, that we cannot make a Chart *for any Part of the World, tho' never ſo ſmall, when ſome of that Part lies in North, and the reſt in South Latitude; for the Equinoctial muſt be a Right Line, or a Circle: If a Right Line, then the Parallels of Latitude will not be equi-diſtant from it, and ſo the Method of Meaſuring Diſtances, by a Scale of Equal Parts, will be loſt. If the Equinoctial* be a Circle, then the Parallels of Latitude on one Side of the Equinoctial will be bigger than the Equinoctial it ſelf, or elſe the Meridians will not be Circles; both which are contrary (as our Author chooſes to expreſs himſelf) to the Difinitions of the Globe. How Rediculous then is it in our Author to find fault with the Mercator's Chart, becauſe the Poles of the World (where Navigation is Impracticable) cannot be laid down therein, when at the ſame time he cannot make a Globular-Chart, for that Part of the Ocean bounded by the Parallels of 5 deg. North, and 5 deg. South Latitude, and by Part of the Coaſt of Guinea on the Eaſt, and the Coaſt of Guiana and Wild Braſil on the Weſt, where Ships ſail almoſt every Day!

In ſhort, when we reflect upon all theſe Errors and Deficiencies that attend not only this, but all other Curv'd-lin'd Charts, we may ceaſe to wonder that our Fore-Fathers ſought after ſome more perfect Method, the happy Effect of whoſe Endeavours at laſt, was the Production of the Mercator's-Chart; which (as Mr Ditton juſtly ſays of the Noble Invention of Fluxions) we all ought to be fond of and admire.

I could, Sir, obſerve to you many other Deficiences and Abſurdities of this Globular-Chart, but I rather decline it, for fear I ſhould treſpaſs too far on your Patience; nor ſhould I have given my ſelf this Trouble, had this Chart been applyed to its right Uſe, viz. The Adorning of Rooms and Stair-Caſes. But when I perceiv'd ſo open and daring Attempt to juſtle out, and that by a mere Abuſe of Words, the moſt excellent Invention, for the End it propoſes, the World ever ſaw, or perhaps ever will ſee, to make way for ſo indifferent a Performance as the Globular-Chart really is; and that they did all this under the Umbrage of your Celebrated Name, thereby endeavouring to make you an Accomplice! I could no longer forbear to expreſs my hearty Reſentment of ſuch vile Practices, and to acquaint you with them! I have accordingly ventur'd to repreſent to you the Premiſes, hoping you will not interpret the Liberty I have taken in making here and there a few Remarks on our Author as they fell in my way, as any Diſreſpect to your ſelf, in him who is without a Compliment,

SIR,

From my SCHOOL,
near Wapping Old-
Stairs, Feb. 14, 1722.

Your moſt Obedient,

and Humble Servant,

Thomas Haſelden.

A Deſcription of Mercator's Chart.

THE great Uſe of Draughts, or the Delineation of Things upon Paper, or upon any other Subſtance, may be gather'd from the continual Practice thereof, in all Arts and Sciences that are converſant about viſible Things, the Neceſſity whereof gave Birth even to the Science of *Geometry* it ſelf; of the various Kinds of which, thoſe only that are taken from the Appearance of Objects upon a Plain, placed in a given Poſition to, and as a given Diſtance from the Eye, have obtain'd, ſtrictly ſpeaking, the Name of Projections. Such are the Stereographick, the Orthographick, and the Gnomonick Projections of the Sphere. But theſe having been found inconvenient in the Art of Navigation upon many Accounts, other Delineations have been invented, wherein the Spherical Surface is ſuppos'd to be ſtretch'd into a Right One, and theſe are wont to be called Charts.

The Lives and Fortunes of Mariners, *&c.* depending in a great Meaſure on the Truth of their Charts, no Pains nor Coſt ought to be thought too great to bring them to the utmoſt poſſible Perfection: To this End Two Things are neceſſary, and becauſe a Chart is no other than the Deſcription of the Surface of the Globe, or ſome part thereof, on a plain Surface; the firſt of thoſe neceſſary Things will be, ſo to draw Lines repreſenting the Meridians and Parallels of the Globe on a Plain, that when Places are laid down thereon, according to their true Latitudes and Longitudes, they may have the ſame Reſpect to each other as they have on the Globe it ſelf.

The Plain Chart being found utterly uncapable of this Property, when any conſiderable Part of the Globe was to be taken in, and it being impoſſible, readily, and with any Certainty, to determine the Bearings of Places, by any of the ſeveral curve-lin'd Charts or Maps, becauſe the ſame Points of two different Compaſſes on them are not parallel to each other, therefore ingenious Men very commendably labour'd to find out ſuch a Contrivance, which might conſiſt altogether of Right Lines, and which, by its Verity, might free us from the Plain, with its Errors; and by its Simplicity, from all that Fatigue and Uncertainty that attends curv'd-lin'd Charts, of what Denomination ſoever. This undoubtedly was their Deſign; and this was firſt hit upon by our worthy Countryman Mr, *Edward Wright*, and is certainly as true, and infinitely betterr adapted to the Mariners Uſe, than even the Globe it ſelf; and ſo excellent was this Invention look'd upon to be even in its Infancy, that ſeveral Perſons attempted, as Mr. *Wright* tells us in his *Preface, To rob him of the Honour of the Firſt Diſcovery, and Mercator, went ſo far in this Point, that it bears his Name to this Day.* They readily apprehended, that to repreſent the true Bearings of Places by Right Lines, which, notwithſtanding they knew in their own Nature to be Spirals, and to be able to meaſure their Diſtances too by a Scale of equal Parts were Things ſo truly wonderful and uſeful, that they could not but think that the Ingenious would eſteem them Inducements ſufficient to introduce this *Chart* into the World, and to prefer it before the *Plain* or any *Curve-lin'd Chart* whatever, which we find verify'd in Fact

But becauſe the Degrees of Latitude are not in this *Chart* equal among themſelves, as they are on the *Globe*, and in thoſe *Plain Charts* that were made Uſe of before this moſt excellent *Chart* was known, and becauſe the Method of meaſuring Diſtances thereon, ſeems to be neither ſo natural nor ſo eaſy as in the *Plain Chart*; alſo becauſe the Apparent Diſtance is moſt commonly longer than the True, which ſeems to contradict the natural Notions we have of Diſtance, therefore ſome People are apt to think this *Chart* cannot be true, but they have no more Reaſon to doubt of the Truth of it upon this Account, than they have to doubt of the Truth of the ſeveral Projections of the *Sphere*, in all which the ſame Things happen: however, I ſuppoſe it may be ſufficient to ſatisfie ſuch, if I tell them that ſince Mr. *Wright*'s Time the greateſt Mathematicians have thought their Time well beſtow'd in Improving and Rendering this very uſeful Invention as ready and eaſy for Practice as might be. The Incomparable Dr. *Wallis* in the Philoſophical Tranſactions, N° 176 (on occaſion of a Paralogiſm committed by Mr. *Norris*) has very fully and clearly prov'd the Truth of it, and taught us a ready Way how to divide the Meridian Line; and our Celebrated Dr. *Halley* was not a little delighted with himſelf when he had only found out an eaſy Demonſtration of the Analogy between the Logarithmic Tangents and the Meridian Line, or Sum of the Secants, a Thing known 50 Years before, as the Reader may ſee in the Philoſophical Tranſactions, N° 219, where, to uſe his own Words, *He hop'd thereby he might be entituled to a Share in the Improvement of this uſeful Part of Geometry, and that none would be ſo diſtingenuous as to depreciate what he had done, or detract from that little Share of Reputation he had in this Thing*, ſo juſtly did he eſteem, and ſo great a Value had he for, this Noble Invention. Nay, ſo well was he ſatisfied of the Excellency and Advantage of this way of repreſenting the Surface of our Terraqueous Globe above all others, that he made uſe of this very Chart to deſcribe his Variation Lines upon, which he never would have done had the Chart been *deficient*; and had he not known it to be infinitely preferable to any other kind of Projection whatſoever, and even to the Globular Projection, as it is now called, and which is as old almoſt as Hydrography it ſelf. But if any one is ſo obſtinate as not to believe on Authorities, tho' ſuch great ones as theſe, he will have the Opportunity very ſhortly of conſulting a Book (it being now in the *Preſs*, and will be contain'd in Two large Volumns in Quarto) written by that ingenious Gentleman Mr. JAMES HODGSON, Teacher of the *Mathematicks* at *Chriſt*'s-*Hoſpital*, wherein that excellent Author hath put the Truth of *Mercator*'s-*Sailing* paſt

Diſpute; and has done that Juſtice not only to this, but to all the other Parts of *Navigation*, the *Sphere*, *Aſtronomy*, &c and in ſo regular a Method, that I don't doubt but the World will ſoon be convinc'd, that it is the beſt Piece of its Kind extant.

The *Mercator*'s then being a true *Chart*, and conſequently capable of ſhewing the true Bearings of Places, when laid down according to their true Latitudes and Longitudes, and of determining the Diſtances alſo, by one or two ſimple and very plain Laws of Meaſurement; the next thing is to aſcertain thoſe true Latitudes and Longitudes, and the beſt way of doing this is by Cœleſtial Obſervation. The Latitudes of Places are eaſily found, and the Method of doing it known to all that have learn'd *Navigation*, tho' the Allowance for Refraction, I fear is too often omitted, which in ſome Voyages, eſpecially to *Archangel*, when 'tis obſerv'd by the loweſt Meridian Altitude of the Sun, will cauſe a conſiderable Errour.

The Longitudes of Places too, (tho' at preſent impracticable at Sea, yet how ſoon it may be made ſo by the great Improvements of late made in the *Magnetical Needle*, by the ingenious and indefatigable Mr. *Whiſton*, I cannot ſay, having not ſeen that Author's (as I hear excellent Contrivance) might be found on the Land by Obſervation, if the induſtrious *Mariner* would but take pains to make himſelf Maſter of all thoſe Helps which *Aſtronomy* affords; ſuch as the Doctrine of Eclipſes of the Sun, Moon, Satelites of Jupiter, the Appulſe of the Moon to fixed Stars, *&c.* and would alſo be at the Expence of proper Inſtruments for making ſuch Obſervations. But if this is not to be expected, then we muſt be content to lay down the Longitudes of Places by leſs certain Helps, *viz.* the Journals of the moſt experienc'd *Mariners*, which if kept by *Mercator's-Sailing*, and found to agree nearly both out and home, not only for one Voyage to the ſame place but for ſeveral, cannot I think, be very far out of the way.

And tho' I doubt not but that there are a great many ingenious Men who uſe the Sea, yet that that Number might be increas'd, that ſo we might have a greater Number of Correct Journals, I humbly preſume to offer what follows.

Firſt, I would adviſe all thoſe that are about to learn *Navigation*, that they would apply themſelves to a proper Maſter, *viz.* to one who makes Teaching his Buſineſs, and if poſſible, to one who has had Experience in the Practice as well as Knowledge in the Theory; for it is certain that both theſe Qualifications in a Teacher, are better than either alone. But if ſuch a Perſon cannot be found, then the Theoriſt ought to be prefer'd. Inſtead of this we find abundance that will apply to any one who will Teach cheapeſt, not conſidering that the very Reaſon why they do ſo, is moſt commonly the want of ſufficient Ability to recommend themſelves any other way. And then we often find too, that as ſoon as one of theſe has been thus Taught, he will immediately undertake to Teach another, and that other a Third, and that Third a Fourth, and ſo on: Now tho' we ſuppoſe the beſt, *viz.* that the firſt Perſon was well Taught, yet if any one will conſider that it is not every one that *knows*, that has the Art of communicating that Knowledge to advantage, ſince this is gain'd by much Practice in Teaching, and ſuppoſes a thro' Knowledge of the Theory, by which one may view a Propoſition all poſſible ways, and ſo be able to give ſo many different Explanations, that if one does not ſtrike his Hearers Underſtanding another may. Whoever conſiders

this,

this, I ſay, will readily grant that every Perſon who learns *Navigation*, is not fit to Teach it, and thoſe who apply themſelves to ſuch, are guilty of an Act of Injuſtice to their very ſelves, by beſtowing their Money and reaping no real Advantage for it; and alſo that this Practice is one of the Cauſes, why in Compariſon of the many that have learn'd this Science, that there are ſo few that are well ſkill'd in it.

I would adviſe in the next Place, that every *Mariner* would learn the Theory as well as the Practice, which would ſhew him the Reaſon of every Thing he does, by which Means he would be prepar'd againſt any extraordinary Caſe that might happen, and be the better enabled to make ſuch Diſcoveries in the Courſe of his Voyages, as might redound not only to his own Honour and Advantage, but to that of his Country too. But perhaps it may here be objected, that every one has not Time nor Ability for theſe Things, this, 'tis true, is an unhappineſs that I believe ſome labour under, yet I am inclin'd to think that many more might attain it than really do, if they would apply both that Time and that Money for this Uſe, which they ſpend in the purſuit of Pleaſures, leſs ſubſtantial and leſs commendable. But thoſe Gentlemen that have Children, whom they all along deſign for the Sea can have no excuſe, for they have Opportunity of putting them to learn betimes, and they would do well to keep them at it ſo long, that by going over and over, as (Youth are wont to do their Arithmetick) they may Learn the Theory thro'ly, and be habituated to it, for it is not the learning a few practical Problems, as is too common, that will make a Man a compleat Artiſt; and *Navigation* is no trifling Knowledge, (and ſo indifferent whether it be thro'ly underſtood or not) but a Science of the utmoſt Importance, becauſe the Good both of the Publick and Private is in Danger from a very ſmall Miſtake committed therein, and therefore it ſhould be learn'd to the utmoſt Perfection; which, as it is a Compound of Geometry and Aſtronomy, Two very Copious Sciences, cannot be done to any tolerable Perfection in ſo ſhort a Time as is generally taken, and by ſuch Teachers as are too frequently employ'd. I would adviſe farther, that ſuch Youths be Inſtructed in Drawing, which is not only a very commendable, but alſo a very uſeful Accompliſhment.

Thus qualify'd, our Ingenious *Mariners* would, no doubt, produce greater Numbers of correct *Journals*; which, if they would interſperſe with uſeful Obſervations, ſuch as the Depths of Water, Bearings and Diſtances of Headlands, the Rangings of Coaſts, ſetting of Currents, Draughts of Harbours, with the Rocks, Sands. *&c.* the Variations of the Compaſs, whereby the Theory thereof might, in Time, come to be ſettled, or whatever elſe might contribute to the Improvement of *Navigation*, and the Correction of our *Charts*, and be pleas'd to communicate them to Mr. *Richard Mount*, on *Tower-Hill*, I am ſure it would be gratefully acknowledg'd, he being a Perſon that will not ſpare any Coſt to bring our Sea *Charts* to the utmoſt Perfection.

I come now to the Conſtruction of the *Chart*, the Chief Difficulty of which (if it may be call'd One) being the Diviſion of the Meridian Line, I will firſt ſhew how that is to be done, and it admits of two Caſes: Firſt, when you are to begin the Diviſion, from that Point in it, thro' which the Equinoctial is to paſs, or from Latitude 00° 00′: The Second is, when you are to begin from ſome Point of North or South Latitude.

Prop. I.

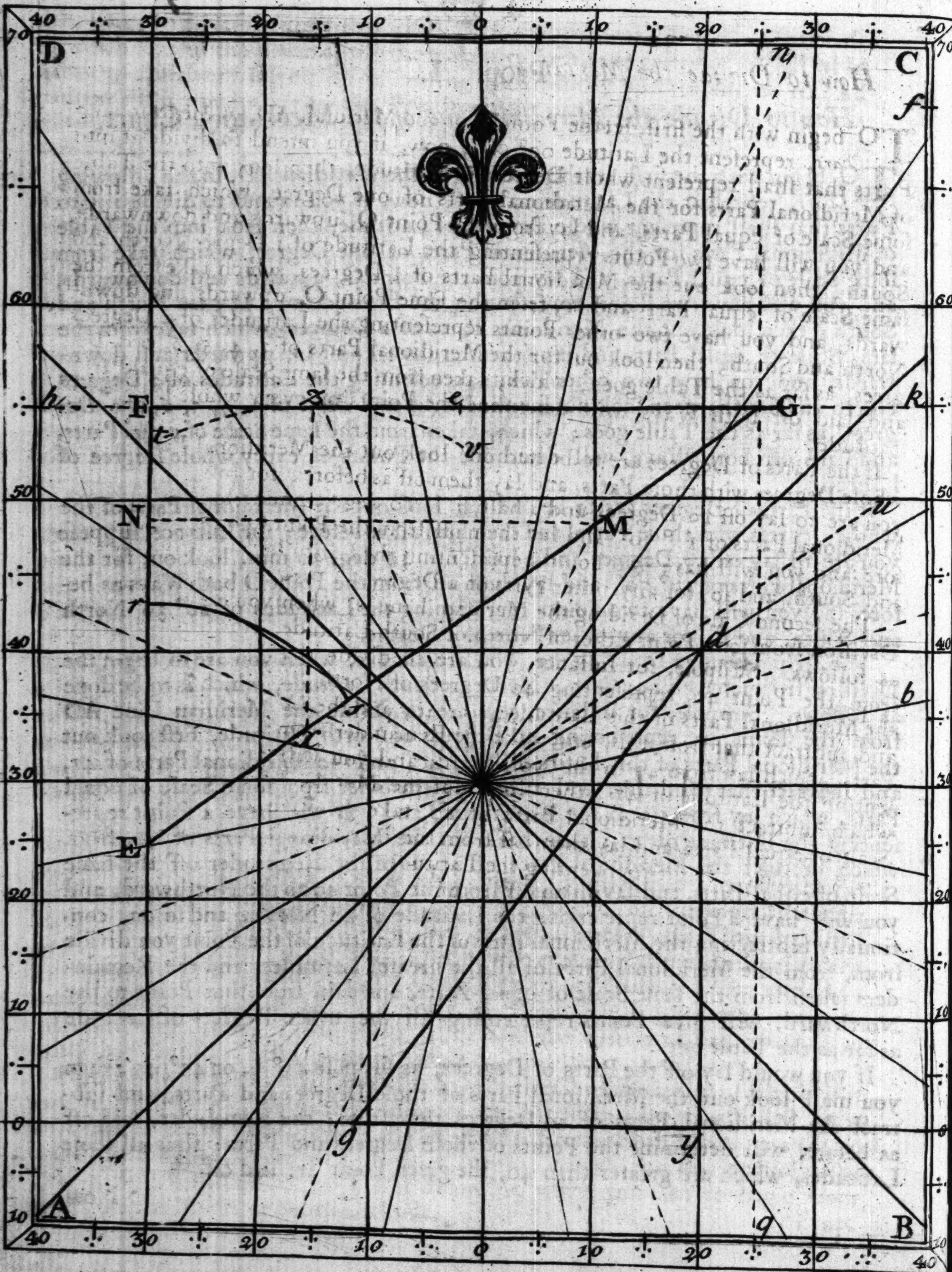
How to Divide the Meridian Line of the Mercator*'s* Chart.

TO begin with the firſt, let the Point O of the Meridian AD, in the following *Chart*, repreſent the Latitude 00° 00′; now, if you intend to divide it into Parts that ſhall repreſent whole Degrees of Latitude, then look into the Table of Meridional Parts for the Meridional Parts of one Degree, which take from ſome Scale of equal Parts, and lay from the Point O, upwards and downwards, and you will have two Points repreſenting the Latitude of 1 Degree North and South; then look out the Meridional Parts of 2 Degrees, which take from the ſame Scale of equal Parts and lay from the ſame Point O, upwards and downwards, and you have two other Points repreſenting the Latitudes of 2 Degrees North and South; then look out for the Meridional Parts of 3, 4, 5, 6, *&c.* Degrees, as far as the Table goes; which, taken from the ſame Scale of equal Parts, and laid off both Ways, will determine the Points of every whole Degree of Latitude.

If the Parts of Degrees are to be laid off, look out the Meridional Parts of the whole Degrees with thoſe Parts, and lay them off as before; for Inſtance, ſuppoſe you are to lay off 10 Degrees and a half, *i. e.* 10 deg. 30 min. look out for the Meridional Parts of 10° 30′: and lay them off from the Point O both Ways as before, and you will have two Points repreſenting the Latitudes of 10° 30′ North and South, and ſo for any other Parts of a Degree.

The ſecond Caſe of Dividing the Meridian Line is, when you are to begin the Diviſion from ſome Point either of North or South Latitude, which is to be done as follows. Suppoſe, for Inſtance, you are to divide the Meridian Line AD from the Point 40, repreſenting 40 Degrees of North Latitude, firſt look out the Meridional Parts of this Latitude, *viz.* 40, and the Meridional Parts of 41, and ſubtract that from this, and take the Remainder from ſome Scale of equal Parts, which lay from 40 to the Northward, and you will have a Point repreſenting the Latitude of 41; then look out the Meridional Parts of 42, from which ſubtract the Meridional Parts of 40, take the Remainder off the ſame Scale of equal Parts, and lay them off from the Point 40 to the Northward, and you will have a Point repreſenting the Latitude of 42 North; and ſo on, continually ſubtracting the Meridional Parts of the Latitude of the Point you divide from, from the Meridional Parts of all the greater Latitudes, and the Remainders taken from the ſame Scale of equal Parts, and laid from that Point to the Northward, will give Points repreſenting all the other Degrees of Latitude as far as the Table goes.

If you would lay off the Parts of Degrees, as ſuppoſe 45° $\frac{3}{4}$, or 45° 45′; then you muſt look out the Meridional Parts of thoſe Degrees and Parts, and ſubtract the Meridional Parts of 40 Degrees therefrom; the Remainder, laid off as before, will determine the Points of thoſe Degrees and Parts; thus all thoſe Latitudes, which are greater than 40, the given Point are laid off.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Now, for thoſe Latitudes that are leſs than 40, the given Point, *viz.* 39, 38, 37, *&c.* look out the Meridional Parts of 39, which ſubtract from the Meridionnal Parts of 40, and lay the Remainder, taken from the ſame Scale of equal Parts, as before, from 40, to the Southward, and you have a Point repreſenting the Latitude of 39; then ſubtract the Meridional Parts of 38, 37, 36, *&c.* from the Meridional Parts of 40, and lay the ſeveral Remainders from 40 the ſame Way, and you have Points repreſenting thoſe reſpective Latitudes: If you would lay off the Parts of Degrees, as ſuppoſe $38\frac{1}{4}$ or 38° 15′, it is to be done in the ſame Manner as the whole Degrees.

Now all this may be expreſs'd in theſe few Words, *viz.* If you are to divide a Meridian Line from Latitude 00° 00′, then the Meridional Parts themſelves, taken from ſome one Scale of equal Parts, and laid from the Point O, where the Equinoctial cuts the Meridian upwards and downwards, will ſhew the Points for the Degrees both of North and South Latitude, whoſe Meridional Parts they are.

But if you are to divide the Meridian Line from any other Point of Latitude, as ſuppoſe 30, 40, 50, *&c.* then the Difference between the Meridional Parts of the Latitude you divide from, and of the Latitude whoſe Point is required to be found, taken from a Scale of equal Parts, and laid from the given Point, will give a Point repreſenting the Latitude required.

And thus you may divide the Meridian Line into Parts that ſhall repreſent every Minute of Latitude if you pleaſe, or every Degree, or only every 5 Degrees, as it is done in the following *Chart.*

Having, by what has been ſaid, deſcribed the Method of dividing the Meridian Line, it will not be difficult to conſtruct a *Chart,* whoſe Limits ſhall extend to what Degrees of Latitude and Longitude you pleaſe.

Prop. II.

To Conſtruct a Mercator's Chart.

FOR Inſtance, ſuppoſe you are to conſtruct a *Chart,* whoſe Limits ſhall be the Latitudes of 10 deg. South, and 70 deg. North, and Longitude 40 deg. Eaſt and Weſt.

Firſt draw the Eaſt and Weſt Line AB, repreſenting the Parallel of the Southermoſt Latitude of the *Chart, viz.* 10 deg South; from one End of which, ſuppoſe A, raiſe the Perpendicular AD, which will be a Meridian Line, this you may proceed to divide from the point A, as directed in the ſecond Caſe of Prop. I. but the ſhorteſt Way will be, becauſe the Equinoctial is in the *Chart,* to look out the Meridional Parts of 10 deg. and ſet it from A towards D, and it will give you the Point O, thro' which the Equinoctial is to paſs, and then divide the Meridian Line from thence by the firſt Caſe of Prop. I. when you have proceeded as far as the Northermoſt Latitude to D, from D draw DC perpendicular to AD, which will be the parallel of the Northermoſt Latitude of the *Chart*; then find the Difference of Longitude that the *Chart* is to contain, which, in this Inſtance, is 80 Degrees: This reduce into Miles, and take from the ſame

Scale of equal Parts, which the Meridional Parts were taken from, and ſet from A and D to B and C, draw the Line BC, and you have the Limits of the *Chart*.

Divide the Line AB, or any other Parallel of Latitude, into 8 equal Parts, and you have every 10 Degrees of Longitude, which may be ſubdivided again by dividing each into ten equal Parts, or into Parts, containing each 5 Degrees, as in this *Chart*, by dividing each into two equal Parts: The Degrees too, if they are large enough to admit it, may be divided into their Halves and Quarters, by dividing each into two or four equal Parts.

It remains now to ſhew the Order, in which the Figures which denominate the Degrees of Latitude and Longitude are to be placed; and as to thoſe of Latitude I need ſay nothing, ſince the Latitude, which every Point of the graduated Meridian repreſents, is determin'd in the Mind, before that Point is found, and therefore muſt be figur'd accordingly; but as to thoſe of Longitude, obſerve what follows: If your *Chart* is to contain part Eaſt and part Weſt Longitude, then the greateſt Weſt Longitude muſt be figured to the weſtermoſt End of the graduated Parallel or Parallels, and the greateſt Eaſt Longitude to the eaſtermoſt End, and the reſt on each ſide in a decreaſing Order, till you come to 00° 00′ which is the firſt Meridian, as you may ſee in this *Chart*.

But if the Sum of the Longitudes ſhould exceed 180 Degrees, and you would have your *Chart* to repreſent the ſhorteſt Way between the two Places that lie in the Limits of the *Chart*, then the leaſt Weſt Longitude muſt be figured to the Eaſt End of the graduated Parallel; and the leaſt Eaſt Longitude to the weſtermoſt End; and the reſt on each ſide, in an increaſing Order, till you come to 180 Degrees, where will be the oppoſite Meridian to the firſt.

If the *Chart* is to contain Weſt Longitude only, then the leaſt Longitude muſt be figured to the eaſtermoſt End of the graduated Parallel, and the reſt in an increaſing Order; but if it is to contain only Eaſt Longitude, then the leaſt Longitude muſt be figur'd to the Weſt End, and the reſt increaſing, till you come to the Eaſtern Limits.

Having thus figur'd the graduated Meridian and Parallel of your *Chart*, you may now draw other Meridians and Parallels parallel to theſe, thro' what Degrees of Latitude and Longitude you pleaſe; which, being deſign'd for the more ready determining the Scituations of Places in the *Chart*, from their known Latitudes and Longitudes, &c. ought not to be too ſparingly drawn, ſo as to require very large Extents of the Compaſſes to reach them from any given Point, nor yet in ſuch Plenty as to cauſe Confuſion; and for finding the Bearings of Places, with Diſpatch, you may alſo draw a little Compaſs in ſeveral convenient Parts of the *Chart*; obſerving herein, alſo, the Caution above given, of the Meridians and Parallels. Thus much in General for the *Conſtruction of a Mercator's Chart, for any Part of the World.*

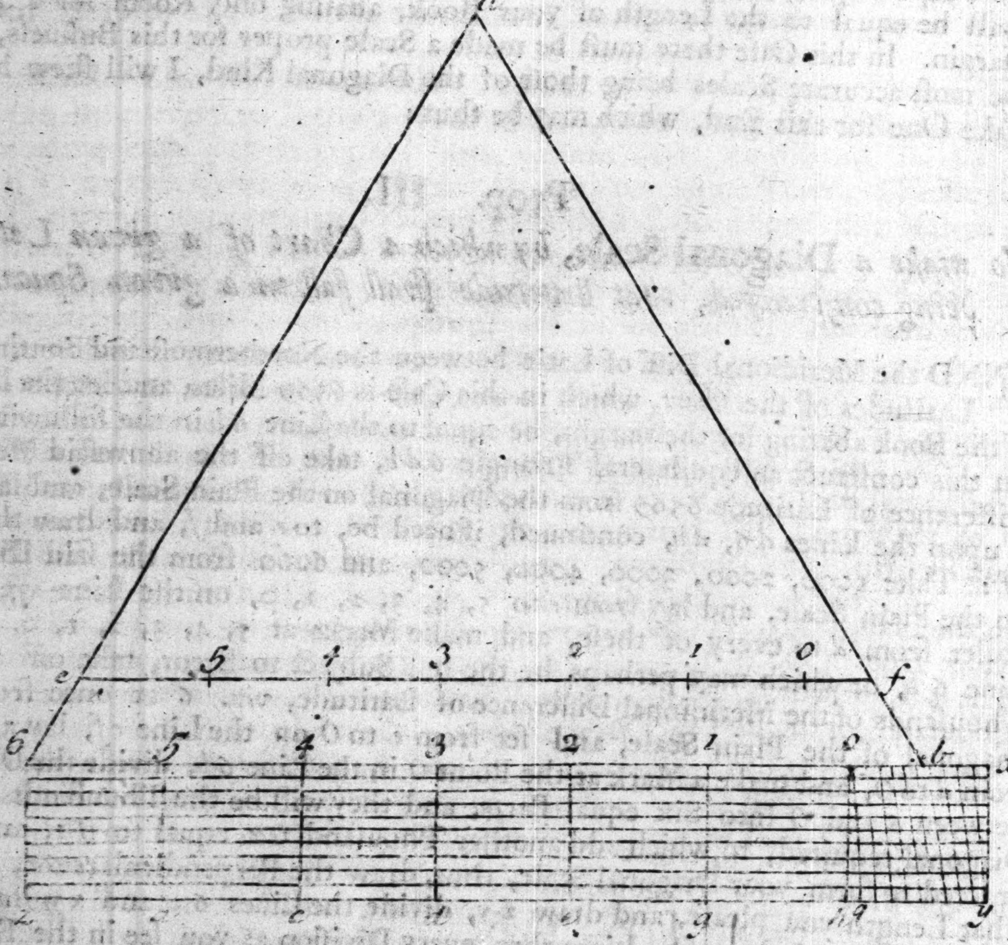
But ſometimes it may happen that the Length or Breadth of the *Chart* muſt be proportion'd to the Paper you are to draw on; as ſuppoſe you are bound on a Voyage from a Place in the Latitude 70 North, and Longitude 40 Weſt, to another in Latitude 10 South, and Longitude 40 Eaſt, and you would make a

Chart on a Paper, and paſte it in your *Journal*, and that the Latitude thereof ſhall be equal to the Length of your Book, abating only Room for a proper Margin. In this Caſe there muſt be made a Scale proper for this Buſineſs, now the moſt accurate Scales being thoſe of the Diagonal Kind, I will ſhew how to make One for this End, which may be thus:

Prop. III.

To make a Diagonal Scale, *by which a Chart of a given Latitude being conſtructed, that Latitude ſhall fall in a given Space.*

FIND the Meridional Diff. of Latit. between the Northermoſt and Southermoſt Latitudes of the *Chart*, which in this Caſe is 6569 Miles, and let the Length of the Book abating for the Margin, be equal to the Line 6 *b* in the following Fig. on this conſtruct an equilateral Triangle 6 *d b*, take off the aboveſaid Meridian Difference of Latitude 6569 from the Diagonal on the Plain Scale, and lay from *d* upon the Lines *d* 6, *d b*, continued, if need be, to *e* and *f*, and draw the Line *e f*: Take 1000, 2000, 3000, 4000, 5000, and 6000 from the ſaid Diagonal on the Plain Scale, and lay from *e* to 5, 4, 3, 2, 1, 0, on the Line *e f*; lay a Ruler from *d* to every of theſe, and make Marks at 5, 4, 3, 2, 1, 0, on the Line 6 *b*, or which may perhaps be the leſs Subject to Error, take off all the Thouſands of the Meridional Difference of Latitude, *viz.* 6 at once from the Diagonal of the Plain Scale, and ſet from *e* to O on the Line *e f*, lay a Ruler from *d* to O, and make a Mark at the Point O in the Line 6 *b*, divide the Diſtance between 6 and O into Six equal Parts, and they will be the Thouſands of the Diagonal required, to which add another Thouſand O *x* equal to O 1, and then proceed to form your Diagonal Scale, thus, draw the Perpendiculars 6 *z*, *x y*, of what Length you pleaſe, and draw *z y*, divide the Lines 6 *z* and *x y* into Ten equal Parts, and draw fine Lines thro' every Diviſion as you ſee in the Figure; draw the Lines 5 *a*, 4 *c*, *&c.* perpendicular to 6 *x*, divide o *x* and *b y* into Ten equal Parts, and draw a fine Line from O to the firſt Diviſion on the Right of *b*, *viz.* c *q*, and then draw the other Lines from every other Point of Diviſion in *x* o to every other Point in *b y*, and the Diagonal Scale is finiſhed, which mark off as you ſee in the Figure. If the whole Meridional Difference of Latitude of the *Chart* had been under a Thouſand, but greater than One Hundred, then inſtead of Thouſands in the foregoing Directions read Hundreds, and you will form a *Scale* proper for that Caſe.

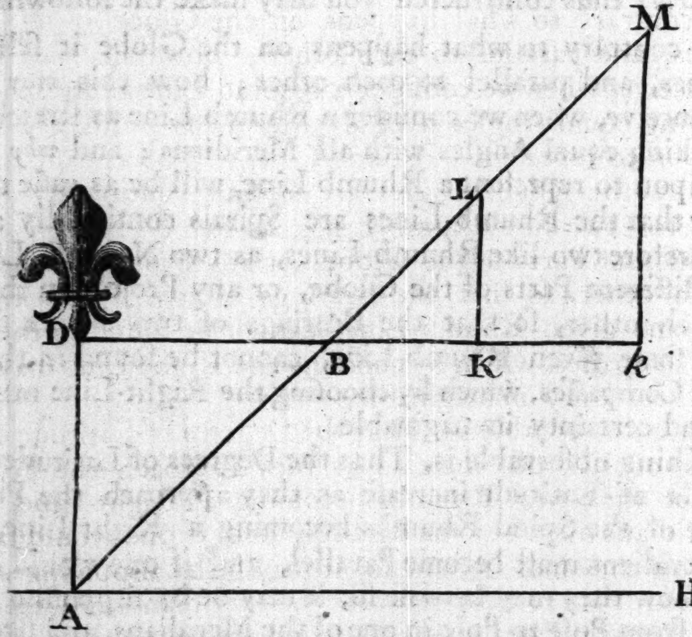


Now if you follow the Directions before given, for Conſtructing your *Chart*, and inſtead of the Scale of Equal Parts there mentioned, you make uſe of this Diagonal Scale, then the Latitudes of your *Chart* will come within the Room required. After the ſame way you may make a Scale to bring the Longitude of your *Chart* into what compaſs you pleaſe; but as when you confine the Latitude to a certain Space, the Longitude cannot be confin'd; ſo if you confine the Longitude then the Latitude cannot, for no Scale can be made that ſhall limit both Latitude and Longitude to what extent you pleaſe: If then when you limit the Latitude of your *Chart* to the Length of your *Journal-Book*, the Longitude ſhould take up ſo much Room, as that part of it fall without the Book, then I ſuppoſe I need not tell you to fold it, in ſuch Manner as that it may fall within.

From the *Chart* thus conſtructed you may make the following Obſervations.

Firſt, That contrary to what happens on the Globe it ſelf, the Meridians are Right-Lines, and parallel to each other; how this *may* be, will not be difficult to conceive, when we conſider a Rhumb Line as ſtretch'd into a Right Line, and making equal Angles with all Meridians; and *why* the Right-Line was pitch'd upon to repreſent a Rhumb-Line, will be as eaſie to be underſtood, if we conſider that the Rhumb-Lines are Spirals continually approaching the Pole, and therefore two like Rhumb-Lines, as two N. N. E. Lines for Inſtance, drawn from different Parts of the Globe, or any Projection thereof cannot be parallel to each other, ſo that the Bearings of two Places from each other, not lying on ſome given Rhumb-Line, cannot be found in the uſual Manner with a Pair of Compaſſes, which by chooſing the Right-Line may be done with all the eaſe and certainty immaginable.

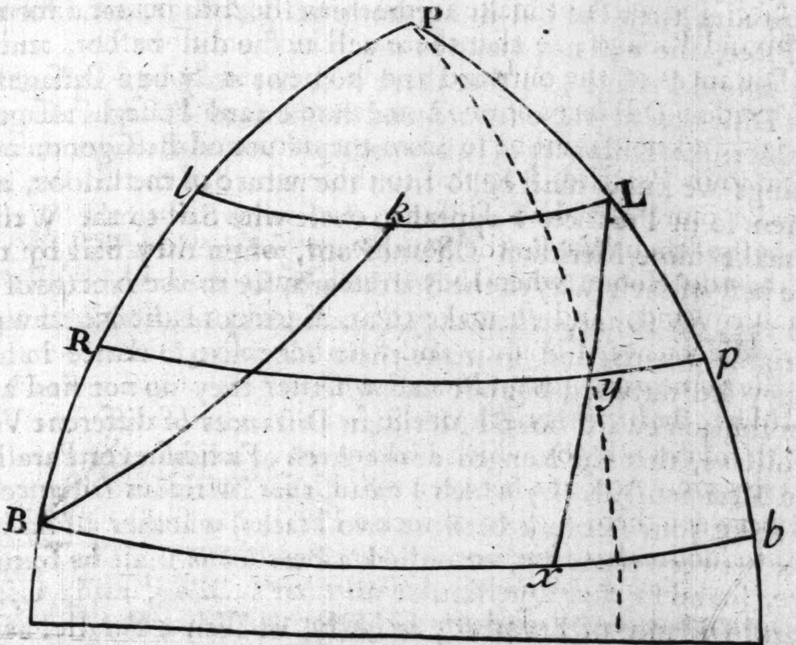
The next Thing obſervable is, That the Degrees of Latitude or the Diſtances of the Parallels of Latitude increaſe as they approach the Pole; this alſo is a Conſequence of the Spiral Rhumbs becoming a Right-Line, for as is ſaid above, the Meridians muſt become Parallel, and if one would frame an Hypotheſis to ſhew how they may become ſo, it may be by ſuppoſing the Surface of the Globe cut from Pole to Pole in one of the Meridians, and ſtretched out from Eaſt to Weſt, 'till each Parallel of Latitude becomes equal to the Equinoctial, but in this diſtorted Plain, 'tis evident that the Places in either of the Hemiſpheres would bear more eaſterly or weſterly from the ſame Point in the Equator, than they did before, and the more ſo, by how much they were neaer to the Poles; but this may be very eaſily rectified again, by only ſuppoſing the Meridians to be made longer, and the Places and conſequently their Parallels of Latitudes mov'd a certain Diſtance farther from the Equinoctial, juſt as in this Queſtion of Sailing; where a Ship at *B* bears N. E. from any Place lying on the Equinoctial *AH*, as *A*; and ſailing due Eaſt 20 or 40 Leagues to *K* or *k*, the demand may be whether ſhe may not by ſailing due North bring her ſelf to bear N. E. from *A* again; the Anſwer will undoubtedly be, that ſhe may, and ſo I ſay too, that Places carried out of their true Poſition by the Surface of the Globe's being diſtorted into a Plain, may by the above-ſaid Method be brought into their true Bearing again; for ſuppoſe *DB* a Parallel of Latitude, which imagine to be ſtretch'd in ſuch Manner that the Point *B* be removed to *K*, in which Poſition it will not bear N. E. from *A*, but if you ſuppoſe *K* to be remov'd due North to *L*, then 'tis plain, that it is brought into the ſame Bearing from *A* as it was before: and if you ſuppoſe the aforeſaid Parallel to have been ſtretch'd to a greater degree, ſuppoſe for Inſtance, till the Point *B* came to *k*, then 'tis plain that *k* muſt be remov'd to *M*, in order to bring it in the ſame Bearing from *A*, which being a greater remove than from *K* to *L*, 'tis plain, not only that Places remov'd out of their true Bearing by the Diſtortion before mentioned,



tioned, may be brought into their true Bearings again, by removing them farther to the Northward or Southward, but the Law of this Removal is in ſome Meaſure as that of the Stretching.

It is true indeed, that as the Parallels of Latitude are made longer than they ſhould be, ſo the apparent Diſtances will be more than the true, but ſince there are very exact Methods at Hand to determine the True from the Apparent's being given, it cannot in the leaſt prejudice this *Chart*, with reſpect to Truth, and as to the Trouble of finding thoſe true Diſtances, if there be any who eſteem it ſuch, this is throughly compenſated for by the ready Method whereby the true Bearings of Places may be found, and which no other Chart can pretend to.

A third Thing obſervable is, That this *Chart* has no ſuch Thing as is commonly ſignify'd by the Words DEPARTURE or MERIDIAN DISTANCE belonging to it; that is, has no Lines in it expreſſing that Thing: Now, that this is a very great Advantage, is as certain, as Merid. Diſt. is uncertain, and that Merid. Diſt. is uncertain and not to be depended upon, will be plain, if it can be made appear, that as many different Paths of the Ocean as a Ship runs over in different Voyages between two Places, ſo many different Meridian Diſtances ſhe will make between them; and in order to this I will ſuppoſe a Ship bound from the *Lizard L*, to *Barbados B*, and Sails due South to *b*, and thence due Weſt to *B*, here her Meridian Diſtance by Account will be equal to the Length of the Arch of the Parallel *b B*, and if ſhe return back again due Eaſt to *b*, and thence due North to *L*, ſhe will then indeed make the ſame Meridian Diſtance Home as Out, but if ſhe return due North to *l*, and thence due Eaſt to *L*. Here the Meridian Diſtance by Account



count will be equal to the Length of the Arch of the Parallel *l L*, which being leſs than *B b*, her Meridian Diſtance Home is leſs than Out, ſo that in this Inſtance 'tis plain, that a Ship makes different Meridian Diſtances between two Places, when ſhe does not return by the ſame Path of the Ocean on which She went out.

For another Inſtance, let us ſuppoſe the Ship to ſail S.S.W. from *L*, till She come into the Parallel *B b*, where let *b x* repreſent her Meridian Diſtance by Account, then ſhe will have the Meridian Diſtance *x B* ſtill to make out; being arrived at *B*, let us ſuppoſe her to return homeward on the oppoſite point to which ſhe went out, *viz.* N. N. E. till ſhe come into the Parallel *l L*, where let *l k* repreſent her Meridian Diſtance by Account, which will be the ſame as *b x*, becauſe they are both found from the ſame Data, but the remaining Meridian Diſtance *k L*, cannot be ſo much as *x B*, becauſe *l L* being leſs than *B b*, when the equal Quantities *l k* and *x b* are ſubſtracted from them both, that which was the leaſt Minuend, *viz. L l*, will leave the leaſt Remainder, *viz. k L* or in other Words, the ſame Quantity of Meridian Diſtance made in a higher Latitude, and taken from the Parallel of that Latitude, muſt leave a leſs Remainder than when taken from the longer Parallel of a lower Latitude.

Univerſally then, if a Ship in returning, or in her homeward bound Paſſage, makes her Meridian Diſtance in the Whole in higher Latitudes than ſhe did in her outward bound Voyage, ſhe will make leſs Home than Out; but if in lower Latitudes, then her Meridian Diſtance will be more Home than Out. Alſo, if a Ship in her homeward bound Paſſage makes her Meridian Diſtance in the Whole, in higher Latitudes than ſhe did in her homeward Paſſage, on a former Voyage to the ſame Place, ſhe will not make ſo much as ſhe did before, and the like in her outward bound Paſſage; ſo that there will not only be a Difference between the Meridian Diſtances of the outward and homeward bound Paſſages, but alſo between the Meridian Diſtances of two homeward bound Paſſages themſelves.

Theſe Things we know muſt be ſo from the nature of the Globe, and that we really find them ſo in Practice, I appeal to thoſe who Sail to the Weſt Indies, if they do not make more Meridian Diſtance out, when they Sail by the *Madera*, and make the beſt of their Way to the Southward, for the Advantage of the Trade-Winds, than they do Home, when they ſtretch away to the Northward to meet with the Variable Winds, and ſo make their Meridian Diſtance in higher Latitudes than they did outward bound, and whether they do not find a Difference even between the homeward bound Meridian Diſtances of different Voyages.

Hence it follows, that the Length of the Arch of whatſoever Parallel you take for your fix'd Meridian Diſt. (by which I mean, that Meridian Diſtance which you expect to make by your Account between two Places) whether *L l* or *b B*, or that of the Middle between them *R p*, or of ſuch a Parallel as ſhall be found equal to the Departure, found in that Queſtion of *Mercator*'s *Sailing*, made Uſe of to find the Bearing and Diſtance of *L* and *B*; or laſtly, of ſuch a Parallel as is equal to the Meridian Diſtance made by Account on a former Voyage, I ſay whichſoever of theſe you take for your fix'd Meridian Diſtance, you can never be ſure after you have made out a part thereof, what the remaining part will be, and conſequently cannot be ſure of either Courſe or Diſtance, becauſe as is ſhewn above, a Ship may make equal Quantities of Meridian Diſtance from a Place, and yet have unequal Quantities ſtill to make to the Place bound to; thus dangerous and deluſive is Departure or Meridian Diſtance.

How excellent then is this Property, and how much does it enhance the Value of the *Mercator's Chart*, that it has no Lines in it expreſſing this uncertain Thing, whereby it might deceive the induſtrious *Mariner*, which now it cannot do, for Difference of Longitude being an Arch of the Equinoctial, contain'd between the Meridians of two Places, and each Days Difference of Longitude being a Part of this, the Parts muſt at all times be equal to the Whole, and ſo in all Caſes muſt be the ſame Home as Out; and thus the *Mercator's Chart* always repreſents it.

Since then this *Chart* cannot deceive us, (ſuppoſing Places laid down in their true Latitudes and Longitudes) we muſt take Care we do not deceive our ſelves, which thoſe Gentlemen always do (except only in the Caſe of a due Eaſt or Weſt Courſe) who do not find their Difference of Longitude at leaſt every Day, but let it alone perhaps a Week or Ten Days, and then find it by help of the Difference of Latitude and Departure made in that Time, for if this were true, we might as well expect that the Reſult of all the daily Departures made between *L* and *B*, whatever Courſes were ſteer'd, would with the Difference of Latitude between *L* and *B* find the true Difference of Longitude between them, which Departures having been prov'd to be different according to the different Tracts of the Ocean a Ship ſails over; it muſt follow that there may be as many different Differences of Longitude between two Places, as there can be made different Meridian Diſtances; which, by the Definition of Difference of Longitude, is abſurd.

But ſome, perhaps, will ſay, if Longitude be true, then muſt Meridian Diſtance be true alſo, becauſe we find that by the Help of this: Now, to ſatisfy thoſe that entertain this Notion, that they are in the Wrong, I will propoſe this Queſtion.

A Ship ſails from L, *in the preceeding Figure, in Latitude* 49° 55′ N, S.S.W. *till ſhe come into Latitude* 31, 32 N. *to* y, *to find the Difference of Longitude.*

Latitudes	49.55	Mer. Parts	3467
	31.32		1995
	18.23	Mer. Diff. Lat.	1472
	60		
Prop. Diff. Lat.	1103		

	° ′	
As Radius	90.00	10.00000
To Tangent Courſe	22.30	9.61722
So is Prop. Diff. Lat.	1103	3.04257
To the Departure	457	~~1~~2.65979
As Prop. Diff. Lat.	1103	3.04257
Is to Departure	457	2.69279
So is Mer. Diff. Lat.	1472	3.16791
To Diff. Longitude	609	2.78513

Here the Difference of Longitude is found by the Meridian Diſtance or Departure, by Account, and is the true Difference of Longitude; and yet the Meridian Diſtance it ſelf is not the true; for, if it were, it would be equal to the Length of the Arch of the Parallel *yp*, which 'tis plain is the Ship's true Diſtance from the Meridian *Pb*: Let us therefore find *yp*; to do which, we have given the Latitude of *yp*, 31, 32, and the Diff. of Longitude *609*, therefore it will be by parallel Sailing,

As Radius	90.00	10.00000
Is to the Diff. Longitude	*609* M.	2.78513
So is the Co-Sine Lat. of yp	58.22	9.93014
To yp, the true Mer. Diſtance	519 M.	~~1~~2.71527
Mer. Diſt. by Account.	457	
	62	

Here you may ſee, that notwithſtanding the Meridian Diſtance 457, found you, your true Difference of Longitude, yet is it ſelf 62 Miles ſhort of your true Diſtance from the Meridian *Pb*: If therefore, when you were at y, you ſhould have Occaſion to ſteer to a Port at *p*, and depend upon your Meridian Diſtance, by Account, for your Guide, when you come to make the Land, you would, by your Account, be 62 Miles up in the Country, as the Sea Phraſe has it.

Hence we may diſcover the Folly of thoſe who propoſe to Conſtruct a True *Chart* for a Voyage between two Places, from what they call the Departure, found in a *Mercators*'s Queſtion, and the true Difference of Latitude between the Places taken as Data.

A fourth Thing obſervable is, that the whole Surface of the Globe may be repreſented in one of theſe *Charts*, the Poles only excepted, where Navigation is impracticable, and therefore is preferable to ſuch *Charts*, wherein we can only lay down the World by Piece-meals, upon a double Account, *viz.* firſt, becauſe the Charge of buying many ſuch *Charts*, is ſav'd: And ſecondly, becauſe the Trouble of Transferring out of one *Chart* into another, is taken away.

A fifth Obſervation on the *Mercator*'s *Chart* may be the Eaſe and Simplicity of its Conſtruction, which every Man muſt allow when he knows that 'tis compos'd wholly of Right Lines, the eaſieſt of all others to be deſcribed: Here are no Curve Lines to be drawn, thro' a Number of Points, which Points, if one has a Mind to draw half a Dozen Compaſſes in his *Chart*, would be almoſt an Age in finding, and when found would require a Hand ſo ſteady, and an Eye ſo good, to trace a fine Line regularly thro' them, that One Man in Five Hundred is not Maſter of; theſe are Troubles and Difficulties that attend indeed all Curve-lin'd *Charts*, but to which the *Mercator*'s is entirely a Stranger.

Thus far concerning the *Chart* it ſelf: I now come to ſhew how to lay down the Places of Lands, Ships, *&c.* from any poſſible Data; in Order to which, it is neceſſary to ſhew,

Prop. IV.

How to trace out with a pair of Compaſſes a Parallel *to any given Line, that ſhall paſs thro' a given Point, without actually deſcribing it.*

SET one Foot of the Compaſſes in the given Point, and take the neareſt Diſtance to the Line given with the other, carry the Compaſſes along with this Extent, one Foot in the given Line, and the other in ſuch manner, that a Line ſuppos'd to be drawn from one Foot to the other, may as near as you can perceive by your Eye, be perpendicular to the given Line; then does that Foot which is out of the given Line, in the progreſſive Motion of the Compaſſes, trace out the Parallel required.

As ſuppoſe you were to draw a Parallel to the Parallel of 50 Degrees of Latitude, in the foregoing *Chart*, that ſhould paſs thro' the point *b*, ſet one Foot in *b*, and take the neareſt diſtance to the Parallel 50.50; with this Extent carry your Compaſſes along with one Foot in the ſaid Parallel, and in the Poſition aforeſaid, and the other will trace out the Parallel *bk*: But if you would be more accurate, then take the neareſt diſtance from the given Point to the given Line, and with this Extent and one Foot in ſome other Point of the Line given, deſcribe an Arch with a Black Lead Pencil, a Line drawn with the ſame, from the Point given to touch this Arch, will be the Line required.

Prop. V.

The Latitude *and* Longitude *of a* Land, *or* Ship, *given, to find a* Point *in the* Chart *that ſhall repreſent it.*

LOOK for the given Latitude in the graduated Meridian, thro' which trace a Parallel with a Pair of Compaſſes, to ſome Parallel of Latitude, or Eaſt and Weſt Line, then look for the given Longitude in the graduated Parallel, and thro' it, with another pair of Compaſſes, trace a Parallel to ſome Meridian, or North and South Line, where theſe two Traces meet is the Point required: For Example.

Suppoſe you would find a Point in this *Chart* that ſhould repreſent a Ship, or a Place lying in the Latitude of 55 deg. North, and Longitude 25 deg. Eaſt.

Thro' the Point *b*, the given Latitude, with a pair of Compaſſes in one Hand, trace the parallel *bk*, to ſome Parallel of Latitude, and at the ſame Time, with another pair of Compaſſes, or Dividers, in the other Hand, trace the Parallel *nq* to ſome Meridian, and thro' 25, the given Longitude. Theſe two Tracts, or the Points of the Compaſſes that trace them, will meet in the Point *G*, which is the Point required: If you would be more exact, deſcribe the ſaid Parallels by the latter of the two Ways, mention'd in *Prop.* the fourth; now, if it were required, which is the Inverſe of this,

Prop. VI.

To find the Latitude *and* Longitude *of any given* Point, *or* Place, *in the* Chart.

THROUGH the given Point, or Place, trace a Parallel of Latitude, by *Prop.* 4, till it meet the graduated Meridian, the Point of Section ſhews the Latitude; then trace a Meridian thro' the given Point, till it meet the graduated Parallel, and the Point of Section ſhews the Longitude of it: For Inſtance,

Suppoſe you would find the Latitude and Longitude of the Point *G*, thro' *G* trace the Parallel *bk*, which cuts the graduated Meridian in *b*, the 55th deg. of North Latitude, then thro' *G* trace the Meridian *nq*, and it cuts the graduated Parallel in *q*, the 25th deg. of Eaſt Longitude; ſo that the Place *G* lies in the Latitude 55 North, and Longitude 25 Eaſt.

Prop. VII.

The Bearing and Diſtance of a Place, *from ſome given* Place *in the* Chart *being given, to find a Point in the* Chart *that ſhall repreſent it:*

O R

The Courſe and Diſtance which a Ship ſails from a given Place, *given to find whereabout in the* Chart *ſhe is.*

THIS admits of three Varieties or Caſes; firſt, when the requir'd Place bears, or the Ship ſails due Eaſt, or Weſt, from the given Place: Second, when it bears, or the Ship ſails upon ſome other Point of the Compaſs, except the North or South: Thirdly, when it bears, or the Ship ſails North or South.

Caſe *the 1ſt, of* Prop. VII.

Suppoſe a Ship ſails from the Point *G*, due Weſt, 1893 Miles, and you would find her Place in the *Chart*:

Thro' the given Point *G* draw the Parallel *h k*, reduce the given Diſtance into Degrees, and it makes 31·33; which, take from the graduated Parallel, and ſet from any Point whatſoever, where a Meridian and a Parallel interſect each other, either Way on that Parallel, as from *y* to *g*; make an Angle at *g*, *viz. dgy*, equal to the Latitude the Ship ſails in, which, in this Example, is 55 deg. and the Diſtance between *g* and *d* the Point where the Line *gd* cuts the Meridian coming from the Section *y*, laid from *G*, on the Parallel *h k*, will determine the Point *F*, the Place of the Ship.

This Caſe may very readily be performed by the Sector, thus: Take the given Diſtance 31,33 from the graduated Parallel, and fit the Complement of the Latitude on the Line of Sines to it, then take the Sine of 90 deg. from the Sector, and lay from *G*, on the Parallel *kh*, and it will reach to *F*, the Place of the Ship: If the Diſtance ſhould be too large for the Sector, you may take $\frac{1}{2}$ or $\frac{1}{4}$ thereof, and proceed as above, and you will determine a Point in the Parallel of the given Latitude *kh*; the Diſtance between which, and the given Place *G* taken, and accordingly turn'd over twice or four times from *G*, will give the Place of the Ship. The Inverſe of this Caſe is,

Prop. VIII.

To find the Diſtance *between two* Places, *lying in the ſame* Latitude *or* Bearing, *Eaſt and Weſt, off each other.*

SUPPOSE it were required to find the Diſtance between *G* and *F*, both lying in the Latitude 55 deg.

Take a Point any where in ſome Meridian; ſuppoſe the Point *d*, at which make an Angle (on either ſide the Meridian) *g d y*, equal to the Complement of the Latitude of the Places, and make *d g* equal to the apparent Diſtance between the two Places *G* and *F*, then the neareſt diſtance from g to the aforeſaid Meridian *d y*, meaſured on the graduated Parallel, will give the Diſtance required, *viz.* 1893 Miles.

This *Prop.* may alſo be done by the *Sector*, with very little Trouble, thus; take the apparent diſtance between *G* and *F* in your Compaſſes, and fit 90 Degrees of the Line of Sines to this Extent, then take the diſtance between the Sines of the Complement of the given Latitude on the *Sector*, and apply it to the graduated Parallel, and you have the true Diſtance in Degrees and Minutes; But if the apparent Diſtance between the two Places ſhould happen to be too large for your *Sector*, then you may take half or a quarter thereof, and proceed as before, and what you find will accordingly be half or a quarter of the true Diſtance.

Prop. VIII. *The Common Way.*

LET *G* and *F* be the two Places whoſe Diſtance is to be found, take half the apparent Diſtance between them, *viz. G e*, in your Compaſſes, ſet one Foot in their Latitude on the graduated Meridian, *viz.* at *k*, and turn the other Foot firſt upwards to *f*, and then downwards to *b*, obſerve what Latitudes the points *f* and *b* are in, and find the Difference of Latitude between them, which will be (tho' not exactly, yet near enough for common Purpoſes) the Diſtance required.

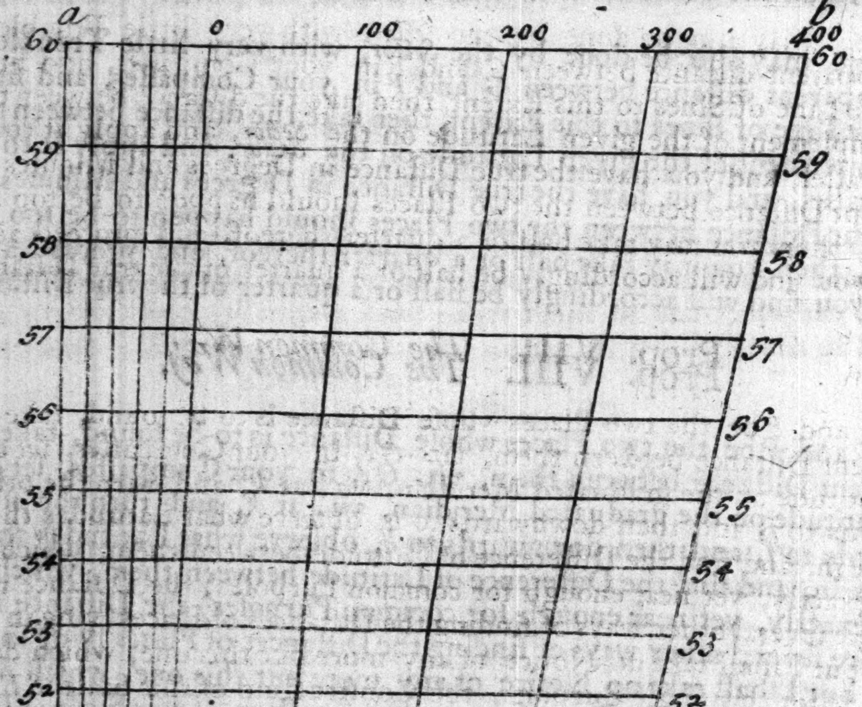
There are ſeveral other ways of finding the Diſtances of Places lying in the ſame Latitude, but I ſhall take no Notice of any more but this one, which does it by a Scale made for this ſingle Purpoſe; the Conſtruction of this Scale *STURMY* has long ſince ſhewn us in his *Magazine*, and I have ſeen the Scale it ſelf in ſeveral *Dutch Charts*, and it might be of good Uſe were it incerted in ours alſo, but that any one may make it himſelf, on a piece of Paper and paſte it on his *Chart*, I will here ſhew the Conſtruction thereof.

Prop. IX.

How to make a Scale for meaſuring the Diſtances of Places that bear Eaſt and Weſt off each other, on the Mercator's Chart.

REduce the Leagues you would have your Scale to contain, into Degrees, as ſuppoſe you would have a Scale to contain 500 Leagues, this reduced makes 25 Degrees, take this 25 from the graduated Parallel of your *Chart*, and fit 1000 of the *Line of Equal Parts* on the *Sector* to this Extent, or if you have not a *Sector* make a *Diagonal Scale*, 1000 of which may be equal thereto, by the Directions before given for making ſuch a *Scale*.

Now ſuppoſe the limits of the *Chart* for which this *Scale* is to be made, to be the Latitudes of 40 and 60, draw the Line *c d*, and a Perpendicular thereto *c a*, look for the leſſer Latitude 40, in the following Table of Natural Secants, and againſt it you will find 1305, which take from the *Sector* or ſaid *Diagonal Scale*, and ſet from *c* to *d*, then ſubſtract the Natural Secant of the leſſer Latitude 1305, from that of the greater 2000, and the Remainder 695 ſet off on the Perpendicular from *c* to *a*, and draw *a b* parallel to *c d*, on which lay off 2000



the Natural Secant of the greater Latitude 60, and joyn *b* and *d*; ſo have you the limits of the *Scale*; now for the intermediate Degrees of Latitude, ſubſtract the Natural Secant of 40, *viz.* 1305, from that of 41, *viz.* 1325, and the Remainder 20 ſet from 40 or *c* to 41, then ſubſtract 1305 from 1346 the Natural Secant of 42, and the Remainder 41 ſet from 40 or *c* to 42, and ſo on till you come to the greateſt Latitude 60; and univerſally, the difference of the Natural Secants of two Latitudes laid from one of thoſe Latitudes will give the other; then draw the Lines 46.46, 47.47, *&c.* parallel to *c d* or *a b*, and divide the Lines *a b* and *c d* into ſo many Equal Parts as the *Scale* is to contain Hundreds, *viz.* 5, (or if the *Scale* had been to contain any Number of Leagues under a Hundred, then into ſo many as there are Tens) in the points 0, 100, 200, 300, *&c.* and one of theſe, *viz. a o* and *c o* into Ten (tho' here becauſe I would not croud the Lines too cloſe, I have divided it but into 5, and therefore each is 20 Leag.) and draw the Lines 0.c, 100.100, 200.200, 300.300, *&c.* and the *Scale* is finiſhed.

A Table of Natural Secants to 84 Degrees of Latitude, for making a Scale *to meaſure the Diſtance of Places on the* Mercator's Chart, *that lie in one and the ſame Latitude.*

Deg	Secants.	Deg.	Secants.	Deg.	Secants.	Deg.	Secants.
0	1000	22	1078	43	1367	64	2281
1	1000	23	1086	44	1390	65	2366
2	1001	24	1095	45	1414	66	2458
3	1001	25	1103	46	1439	67	2559
4	1002	26	1113	47	1466	68	2669
5	1004	27	1122	48	1494	69	2790
6	1005	28	1132	49	1524	70	2924
7	1007	29	1143	50	1556	71	3071
8	1010	30	1155	51	1589	72	3236
9	1012	31	1167	52	1624	73	3420
10	1015	32	1179	53	1662	74	3628
11	1019	33	1192	54	1701	75	3864
12	1022	34	1206	55	1743	76	4133
13	1026	35	1221	56	1788	77	4445
14	1031	36	1236	57	1836	78	4810
15	1035	37	1252	58	1887	79	5241
16	1040	38	1269	59	1942	80	5759
17	1046	39	1287	60	2000	81	6392
18	1051	40	1305	61	2063	82	7285
19	1058	41	1325	62	2130	83	8205
20	1064	42	1346	63	2203	84	9567
21	1071						

Note, If the Degrees of Latitude ſhould croud too clooſe together, when you make uſe of but one Scale of equal Parts in the Projecting of this Scale, then you are at liberty to make uſe of a bigger, as you ſhall think fit wherewith to lay off the Difference of the Secants on *c a*, but not for the Secants themſelves on *c d* and *a b*, which muſt always be taken from that *Scale* of Equal Parts, 1000 of which was made equal to the Degrees contained in the Leagues of your required *Scale*, which is here 25.

Prop. VIII. *By the* Scale.

IN this *Scale* the croſs Lines *c d*, *a b* and all the reſt that are parallel to theſe, are nothing elſe but ſo many Scales of Equal Parts, each proper for meaſuring Diſtances in its own reſpective Latitude; therefore when you would meaſure the Diſtance between two Places that lie in the ſame Latitude, you muſt firſt know what Latitude they are in, which Latitude you muſt look for in this *Scale*; and the Line that paſſes through it, is a Line of Equal Parts, by which all Diſtances in that Latitude muſt be meaſured or laid off, in the ſame manner as it is uſual to do by any other Line of Equal Parts whatſoever, which I think every one that has learn'd Navigation muſt be acquainted with: Thus if you meaſure the Diſtance from *G* to *F*, in the foregoing *Chart*, on the Line 55. 55 in the *Scale*, which is the Latitude of thoſe Places, in the ſame manner as you would meaſure any other Line, by any Line of Equal Parts on the Plain *Scale*, you will find it to be 631 Leagues.

Caſe the 2d, *of Prop.* 7th,

Suppoſe a Ship ſails from *E*, North 53° 46′ Eaſt 3045 Miles, to find the Place of the Ship.

Firſt, thro' the Point *E* draw a Meridian with a Black-Lead Pencil, made very ſharp at the Point; then with the Chord of 60 deſcribe the Arch *r s* with a Black-lead Pencil alſo; on which lay off the Chord of the given Courſe 53. 46, from *r* to *s*, and draw the Line *E G*, then reduce the Diſtance 3054 Miles into Degrees, and it will be 50° 45′, which take from the graduated Parallel *AB* or *C D*, and lay from *E* to *M*, and draw the Parallel of Latitude *M N*; take the Difference of Latidude *E N* in your Compaſſes, and apply to the graduated Parallel, and ſee how much it meaſures, here it will be 30 deg. with this Difference of Latitude, and the Latitude of E. find another Latitude, which in this Caſe will be 55 deg. North; through this Latitude deſcribe the Parallel *b k*, and it will cut the Line *EG* in *G*, which is the Place of the Ship required.

If the Courſe had been ſome whole Point, ſuppoſe ENE. then there had been no need of this Method by the Chords, ſince a Line drawn from the Point *E*, parallel to ſome given *ENE.* in the Chart, would have been an *ENE.* from *E*. The Inverſe of this and which is of moſt frequent uſe in Sailing is,

Prop.

Prop. X.

To find the Bearing and Diſtance of two Places that differ both in Latitude *and* Longitude, *or that do not bear North and South, nor Eaſt and Weſt off each other.*

FIND the Latitude of each Place by *Prop. 6.* and thereby the Difference of Latitude in Degrees and Minutes, which take in your Compaſſes from the graduated Parallel, then lay a Ruler or Scale from one Place to the other; and move one Foot of your Compaſſes, with the aforeſaid Extent of Difference of Latitude in them, by the Edge of the Ruler, backwards and forwards, 'till the other Foot turn'd about will juſt touch ſome Eaſt and Weſt Line that cuts the Edge of the Ruler, when it dos ſo, keep that Foot which is by the Edge of the Ruler faſt, and open your Compaſſes 'till the other Foot reach the Interſection of the ſaid Eaſt and Weſt Line, and the Ruler; this Extent meaſur'd on the graduated Parallel, will ſhew the Diſtance between the two Places in Degrees and Minutes. For Inſtance,

Suppoſe a Ship at *G*, and you would find her Bearing and Diſtance from the point *E*, or of *E* from her.

The Latitude of *G* is 55 Degrees North, and of *E* 25 Degrees North, and conſequently the Difference of Latitude 30 Degrees; let the Line *E G* repreſent the Edge of the Ruler, take 30 Degrees from the graduated Parallel, and ſet one Foot by the Side of the Ruler, (that is on this Line) and move it backward and forward till the other point will deſcribe the Arch *t v*, touching the Parallel *F G*, at which time the Foot which is carried along by the Side of the Ruler will reſt at *x*, then is *x G* the Diſtance required, which muſt be taken in your Compaſſes and meaſured on the graduated Parallel, and it makes 50 deg. 45 min. or 3045 Miles.

The Bearing may be found thus, ſet one Foot of your Compaſſes in the Center of that Compaſs, *viz. c*, which is neareſt to the ſaid Edge of the *Scale*, and take the neareſt Diſtance thereto, with this Extent trace a Parallel *c u* to the Edge of the Ruler, and you will ſee by the Compaſs, what point thereof this Tract runs over, or neareſt too, which in this Caſe is North Eaſt, and as near as can be determined by the Eye three quarters Eaſterly, and ſo the Ship at *G* bears off the Place at *E*, and conſequently *E* bears from the Ship South Weſt three quarters Weſt.

But if you intend to be more exact, then draw a Meridian thro' *E*, and alſo the Line of Bearing *E G*, with a Black-lead Pencil, and meaſure the Angle *F E G* by a Line of Chords, and you have the Bearing as exact as 'tis poſſible to be found by Inſtrumental Operation.

That the Law laid down for meaſuring Diſtances in this Prop. is general, and will bring out the ſame as the Calculation, may be ſeen in the Triangle *E F G*, wherein EF is the apparent Difference of Latitude commonly called the Meridional Difference of Latitude, and FG the Difference of Longitude; now becauſe the apparent Difference of Latitude in the *Chart* EF, bears the ſame Proportion to the apparent Diſtance EG, as the true Difference of Latitude on the Globe, does to the true Diſtance on the Rhumb on the Globe, as has been ſhewn by Mr. *Wright* in his *Correction of Errors*; to expreſs this Proportion it has been uſual to form the Triangle ENM ſimilar to EFG, wherein EN is made equal to the true Difference of Latitude, and conſequently EM equal to the true Diſtance, but the ſame Proportion might as well have been expreſſed by the Triangle xzG, by making xz equal to the true Difference of Latitude, and parallel to EF, for then the Triangle xzG will be ſimilar and equal to ENM, and ſo xG equal to EM; now that this is the very Method made Uſe of in this Prop. appears thus, E and G are the two Places between which the Diſtance is to be found, and the Line EG repreſents the Ruler laid from one to the other, now the Compaſſes with the Extent of true Difference of Latitude, taken from the ſame *Scale* that the *Chart* was made from, or one equivalent thereto, *viz.* the graduated Parallel, if one Foot be mov'd along the Ruler EG it will reſt at x, when the other turn'd about will touch ſome Eaſt or Weſt Line FG at z, then if the Line xz be ſuppos'd to be drawn, the Angle xzG ſhall be a Right Angle by *18th Euclid* the *3d*, and ſo equal to ENM, alſo xz is parallel to EF by the *28th* of the *1ſt*; therefore by the *29th* of the ſame, the Angle zxG is equal to NEM, and the Side xz is equal to EN by Conſtruction, therefore by the *26th* of the *1ſt*, the Triangle xzG is equal to ENM, and conſequently xG equal to EM; ſo that the Diſtance from the point x (where the Foot of the Compaſſes reſts by the Side of the Ruler) to G, (where the Parallel which the other touch'd cuts the Ruler) taken and meaſured on the graduated Parallel, will be the true Diſtance.

Prop. X. *By the foregoing Scale:*

LET the Diſtance between E and G be required, firſt you muſt find the Latitude of each Place, *viz.* of G which is 55, and E 25, then find the Middle Latitude which is 40, look for the Middle Latitude 40 in the *Scale*, and the Line 40. 40, is a *Scale* of *Equal Parts* proper to meaſure the Diſtance from E to G, ſee therefore how many of theſe Parts are contain'd in EG, and ſo many Leag. is the Diſtance required.

Note, This *Scale* is not exactly true in all Examples of this Prop. for in the above Inſtance it differs above 20 Leagues from the Truth, yet it may ſerve well enough in ſmall Diſtances, or in pretty large ones in low Latitudes, or if the Bearing be not far from Eaſt and Weſt, even in high Latitudes.

Caſe the 3d, *of Prop. the* 7th.

Reduce the Diſtance given into Degrees and Minutes, which being the Difference of Latitude as well as Diſtance, with it and the Latitude of the given Place find what Latitude the required Place or the Ship ought to lye in, thro' which trace a Parallel of Latitude, and thro' the Place given a Meridian, by Prop. the *1ſt*, where theſe two meet is the point required. For *Example*, Suppoſe a Place bears due North from *E* 1800 Miles, or ſuppoſe a Ship ſails due North from *E* the ſame Diſtance, 'tis requir'd to find a Point in the *Chart*, that ſhall ſhew where ſhe is.

The Diſtance 1800 Miles makes 30 Degrees, *E* lies in the Latitude 25 North, to which 30 being added, becauſe the Ship ſails Northerly, makes 55; thro' this trace the Parallel *bk*, and thro' *E*, the Meridian *EF*, and they meet in *F*, which is the Point required. Now, if it were required which is the Inverſe of this *Prop.*

Prop. XI.

To find the Diſtance between two Places that bear North and South off each other, or that lie under the ſame Meridian, or that are in the ſame Longitude; for all theſe Expreſſions have the ſame Meaning.

'TIS plain, from what goes before, that the Difference of Latitude between the two Places is their Diſtance: Therefore find the Latitude of each Place by *Prop.* the Third; which, if both North, or both South, their Difference; but, if one be North, and the other South, their Sum is the Diſtance required in Degrees and Minutes, which you may reduce into Miles or Leagues, and you have the Diſtance in Miles or Leagues.

Prop. XII.

Courſe ſteer'd from a given Place, with the Difference of Latitude made on that Courſe given, to find the Place of the Ship.

O R,

The Difference of Latitude and Bearing between two Places being known, from the Place of the one, to find the Place of the other.

A Ship ſails from the Point *E*, in Latitude 25 North, North 53.46 Eaſt, till ſhe obſerve her ſelf in the Latitude 55 deg. I would know the Place of the Ship.

Thro' *E* draw a Meridian *EF*, and make the Angle *FEG* equal to 53° 46', the given Courſe; thro' the 55th Degree, the Latitude the Ship is come into, draw the Parallel *bk*, which will cut the Courſe *EG*, in *G*, the Place of the Ship required.

Prop. XIII.

Courſe ſteer'd from a given Place, and the Difference of Longitude made on that Courſe, given to find the Place of the Ship.

A Ship ſails from *E*, in Longitude 30 deg. Weſt, North 53° 46′ Eaſt, till ſhe come into Longitude 25 deg. Eaſt. I would know the Place of the Ship.

Thro' *E* draw the Meridian *EF*, and make the Angle *FEG* equal to 53° 46′, the Courſe given, thro' the given Longitude, *viz.* the 25th deg. Eaſt, draw the Meridian *nq*, which will cut the Courſe *EG*, in *G*; the Place of the Ship requir'd.

In theſe Caſes, where the Courſe is given, if it ſhould be any whole Point of the Compaſs, as N.E. or N.E. by E. *&c.* then there is ſome Labour ſav'd; for then no more is requir'd to be done, than thro' the Place ſail'd from, to draw a Line Parallel to that Point of the Compaſs, already drawn in ſome Compaſs in the *Chart*.

Prop. XIV.

The Latitude of two Places, and the Diſtance between them, given, from the Place of the one, to find that of the other.

ONE Place *E*, in Latitude 25 Degrees North; another *G*, in the Latitude 55 North, diſtant from *E* 3045 Miles, and lying to the Eaſtward thereof; I demand the Place of *G*.

Firſt find the Difference of Latitude, which is 30 Degrees, take this from the graduated Parallel, and ſet from *E* (on a Meridian drawn thro' *E*) to *N*, draw *NM*, a Parallel of Latitude thro' *N*, then reduce the given Diſtance 3045 into Degrees, which makes 50° 45′; take this from the graduated Parallel, and with one Foot of your Compaſſes in *E*, croſs the Parallel *NM* in *M*, and draw *EM*, till it meets the Parallel of Latitude, of the requir'd Place in *G*, then is *G* the Place requir'd.

Thus I have ſhewn how to prick off the Place of a Ship, or Land, from any poſſible Data, with the utmoſt inſtrumental Accuracy; the Truth of which any one will perceive, if he conſiders that theſe ſeveral Caſes are no other than the Caſes of *Mercator*'s Sailing, projected in the *Chart*, in the ſame Manner as on a Slate, from the graduated Parallel, made uſe of as a Line of equal Parts.

All theſe Propoſitions might have been perform'd, but not with that certainty, without the actual drawing of Lines, (which, perhaps, ſome may think a Defacing of their *Chart*; tho' being drawn with Black-Lead, they are eaſily taken out again with Bread:) but, becauſe it would require many Words to ſhew the Manner how, tho' eaſy in it ſelf, I have omitted it in thoſe Propoſitions, which are of leſs frequent Uſe.

But ſome, perhaps, may object that theſe Methods are very puzling and difficult; ſuppoſing this, tho' I can by no Means be brought to think ſo; yet, to this it may be reply'd, that they are very exact, and that no *Chart* whatſoever can pretend to ſhorter, without departing from that Accuracy peculiar to this *Chart*.

To conclude, of all the ſeveral Kinds of *Charts*, thoſe that are equally true with *Mercator's*, are more puzling and difficult; and thoſe that are leſs puzling and difficult want Truth on their ſide.

I therefore recommend it to the induſtrious Mariner, having my ſelf, found it ſo, thro' the Courſe of near Twenty Years Experience at Sea, as at once both the moſt true and expeditious *Chart* in the World.

POSTSCRIPT.

OF the many groundleſs Objections that have of late been rais'd by prejudic'd Perſons againſt the *Mercator's-Chart*, if there be any that has ſo much as the leaſt Colour of a real One, it is this; *viz.* that we have not hitherto been Maſters of a Method to meaſure and lay off Diſtances thereon, with one Extent of a Pair of Compaſſes. I have been very deſirous, both upon Account of rendering ſo excellent an Invention as the *Mercator's-Chart* as ready in Practice as poſſible; as, alſo, that I might take away all manner of Cavil from a Sett of Men, who have for Self-intereſt, endeavour'd to undermine its Reputation, to find out ſome Way whereby this Propoſition might be effected; and I at laſt fell upon a Method which I ſhall here give Account of.

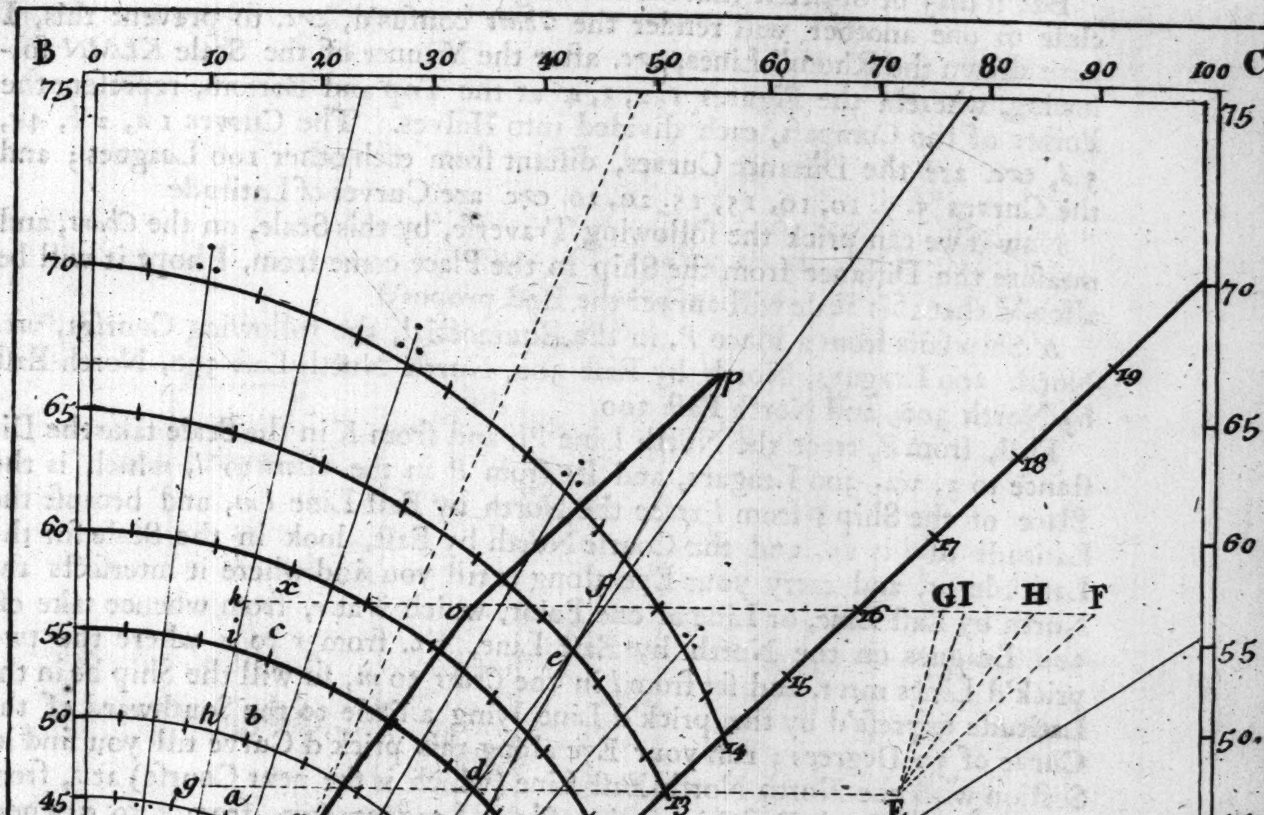
The following Figure *ABCD* is a *Mercator's-Chart*, *AD* the Equator; from *A* let the Rhumb Lines be drawn; now, if on every one of theſe Rhumbs be laid off ſo much apparent Diſtance as anſwers to 100 Leagues of true Diſtance; and, again, from the ſame Point, as much as anſwers to 200, 300, 400, *&c.* of true Diſtance, as it is done on the North-Eaſt Line: From hence we ſhall have a Method of meaſuring and laying off Diſtances on a given Courſe at one Extent of the Compaſſes: For Inſtance, ſuppoſe a Place at *E*, and another at *F*, which bear North-Eaſt and South-Weſt one from the other, and we would find their Diſtance, firſt thro' *E* and *F* trace a Parallel of Latitude, which will cut the graduated North-Eaſt Line at 13 and 16, and form the Parallelogram 13.16 *FF*, in which the Side 13.16, by the 34*th* of the 1*ſt* Euclid, is equal to *EF*; but the Side 13. 16 is equal to the apparent Diſtance that anſwers to 300 Leagues of true Diſtance, by Conſtruction, therefore *EF* is the ſame; and conſequently the true Diſtance from the Place *E* to the Place *F* is 300 Leagues. Hence, if a Ship ſails from *E*, North-Eaſt 300 Leagues, and her Place in the

Chart be requir'd, we muſt trace a Parallel of Latitude thro' *E*, till it cut the divided North-Eaſt Line, which will be at 13, from thence take the Diſtance to 16, *viz.* 300 Leagues, and lay from *E*, on a North-Eaſt Line, and it will fall at *F*, the Place of the Ship.

Another Example ſhall be to find the Diſtance from *E* to *H*, which bear North-Eaſt by North, and South-Weſt by South off each other; firſt trace a Parallel of Latitude thro' *E* and *H*, till that from *E* meets the divided North-Eaſt by North Line in *d*, and that from *G* meets it a little above *e*; this ſhews that the Diſtance from *E* to *H* is 200 Leagues, and ſomething more, *viz.* ſo much as 'tis from *e* to *f*: Again, ſuppoſe we would find the Diſtance from *E* to *G*, which bear North by Eaſt and South by Weſt off each other. Trace a Parallel of Latitude thro' *E* and *G*, till that from *E* cuts the divided North by Eaſt Line in *g*, and that from *G* in *k*, which ſhews that the true Diſtance is 100 Leagues; and ſo much more as 'tis from *i* to *k*, and from *h* to *g*. Indeed how much theſe Parts are we cannot preciſely determine, becauſe the Rhumb-Lines are here divided but to every Hundred Leagues, but had they been divided into Parts, each containing a ſmaller Portion of Diſtance, as ſuppoſe a League, a Mile, &c. then we could determine the Diſtances of Places to the fourth Part of a League, a Mile, &c.

Theſe Examples may Suffice to ſhew the Method of Meaſuring Diſtances when the Courſe is a whole Point or Points; but ſhould it happen to be moreover a Part or Parts of a Point, then it will be neceſſary to draw the *Diſtance Curves*, 70, 14, 65, 13, &c. thro' every Hundred, Ten, Five, or ſingle League of Diſtance, and thereon to ſet Dots repreſenting the Half and quarter Points of the Compaſs, as may be ſeen in this *Chart*: Now, ſuppoſe we would find the Diſtance between *E* and *I*, which bear North by Eaſt ¼ Eaſt, and South by Weſt ¼ Weſt, from each other; firſt trace a Parallel of Latitude thro' each Place, and that thro' *E* will come right againſt North by Eaſt ¼ Eaſt at *a*, and that from *I* at *x*, ſo that *ax* is the true Diſtance, which bein made up of the Parts *be* 100 Leagues, and of the other two Parts *b a* and *e x* t be determin'd by Inſpection, as above, 'tis plain, that the whole Diſtance may be readily diſcover'd; the ſame Method is to be obſerv'd when the Courſe is a Point or Points, with the half Quarters, &c.

Hence it appears that the whole *Chart* it ſelf is one continu'd Scale.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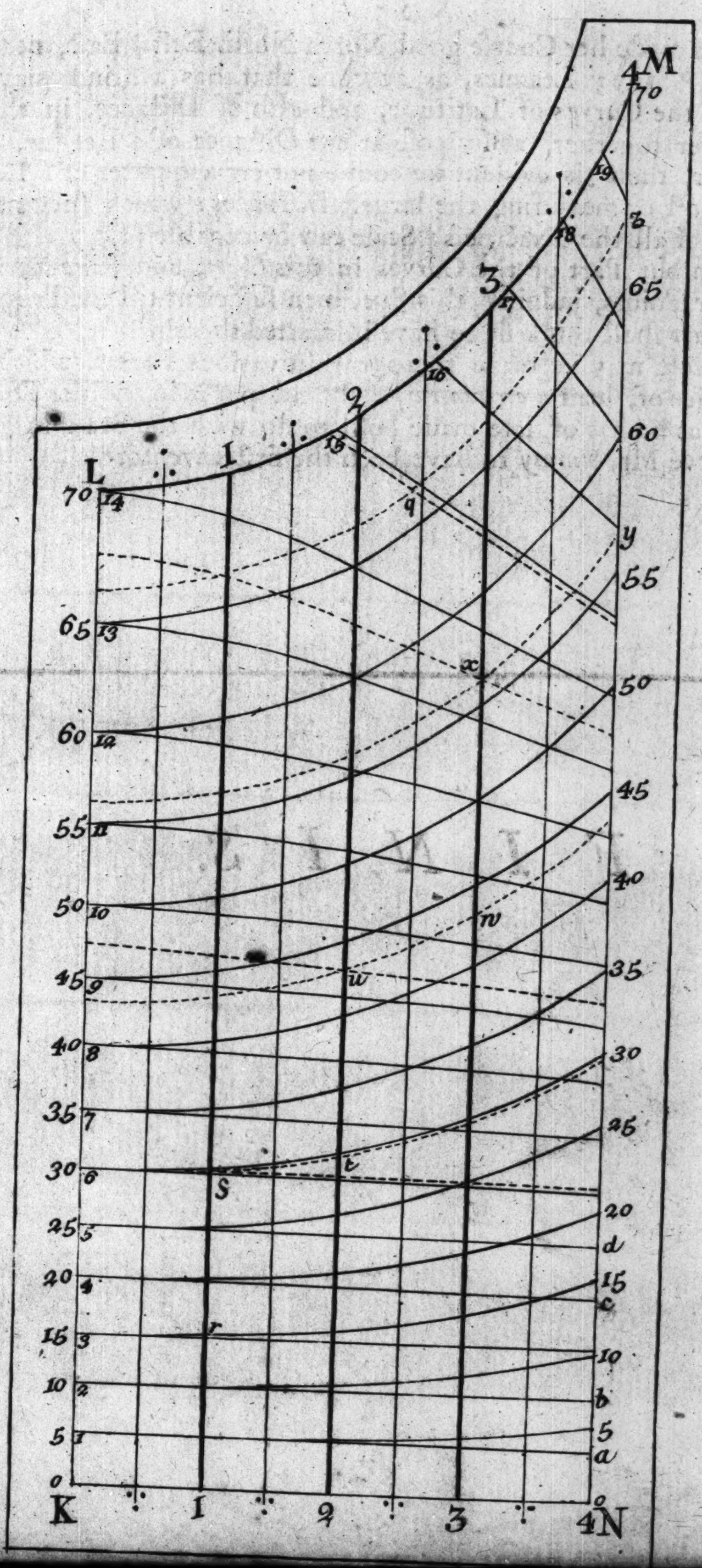
But it may be objected that the drawing the Curves of Diſtance ſo thick and cloſe to one another will render the *Chart* confus'd, *&c.* to prevent this, I have drawn the Rhumb-Lines, *&c.* after the Manner of the Scale *KLMN* following, wherein the Figures 1, 2, 3, 4 at the Top and Bottom, repreſent the Points of the Compaſs, each divided into Halves. The Curves 1 *a*, 2 *b*, 4 *c*, 5 *d*, *&c.* are the Diſtance Curves, diſtant from each other 100 Leagues; and the Curves 5, 5. 10, 10. 15, 15. 20, 20. *&c.* are Curves of Latitude.

Now if we can prick the following Traverſe, by this Scale, on the *Chart*, and meaſure the Diſtance from the Ship to the Place come from, I hope it will be allow'd that this Scale will anſwer the End propos'd.

A Ship ſails from a Place *P*, in the Equinoctial, the following Courſes, *viz.* North 300 Leagues, North by Eaſt 300, North North-Eaſt 300, North-Eaſt by North 300, and North Eaſt 300.

Firſt, from *P*, trace the North Line *Pl*, and from *K* in the Scale take the Diſtance to 3, *viz.* 300 Leagues, and ſet from *P* in the *Chart* to *l*, which is the Place of the Ship; from *l* trace the North by Eaſt Line *l m*, and becauſe the Latitude of *l* is 15, and the Courſe North by Eaſt, look in the Scale for the Latitude 15, and carry your Eye along it till you find where it interſects the North by Eaſt Line, or Line of one Point, which is at *r*, from whence take off 300 Leagues on the North by Eaſt Line, *viz.* from *r* to *s* where the two prick'd Lines meet, and ſet from *l* in the *Chart* to *m*, ſo will the Ship be in the Latitude expreſs'd by the prick'd Line lying a little to the Southward of the Curve of 30 Degrees; run your Eye along this prick'd Curve till you find its Section with the North North-Eaſt Line (which is the next Courſe) at *t*, from which North North-Eaſt Lines take off 300 Leagues, (*viz.* from *t* to *u* where the two prick'd Curves interſect each other) and lay from *m* in the *Chart* on a North North-Eaſt Line to *n*; from *n* trace a North-Eaſt by North Line towards *o*; come to the Scale again, and look for the Latitude the Ship was in when at *n*, which is repreſented by the prick'd Curve a little below the Curve of 45, and run your Eye along it till you diſcover its Interſection with the North-Eaſt by North Line, or Line of 3 Points, which is at *w*; from *w* take the Diſtance to *x*, which is 300 Leagues, and ſet from *n* in the *Chart* to *o*; from *o* trace a North-Eaſt Line towards *p*; go to the Scale again, and look for the Latitude you were in when at *o* in the *Chart*, which is repreſented by the prick'd Curve paſſing thro' *x* in the Scale; then run your Eye along this prick'd Curve till it meets with the North-Eaſt Line, or Line of 4 Points, which will be at *y*; from *y* take the Diſtance to *z*, *viz.* 300 Leagues, and ſet from *o* in the *Chart* to *p*, and this will be the Place of the Ship; from whence draw the Diſtance Line *p P*, which, by comparing what Point of the Compaſs 'tis neareſt to, will be found to be North North Eaſt $\frac{3}{8}$ Eaſt; look in the Scale for the Ship's Latitude when at *p*, repreſented by the prick'd Curve paſſing thro' *z*, and run your Eye along the North North-Eaſt $\frac{3}{8}$ Eaſt Line, or Line of 2 $\frac{3}{8}$ Points, which you will find to interſect the ſaid prick'd Curve of Latititude in *q*, and this, to the Eye, ſeems to want about 6 or 7 Leagues of 1500; ſo

that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that the Ship has made her Courſe good North North Eaſt $\frac{1}{4}$ Eaſt, nearly, and is diſtant from *P* 1493 Leagues, as any one that has a Mind may try by Calculation. If the Curves of Latitude, and alſo of Diſtance, in this Scale, were drawn cloſer together, as ſuppoſe at the Diſtance of a League, or Mile, from each other, then 'tis evident we could not err a quarter of a League or Mile in taking off or meaſuring the largeſt Diſtances; which ſhews that this Scale is capable of all the Exactneſs a Scale can be capable of.

I have drawn but Part of the Curves in this *Chart*, and have carried the Scale but to four Points, judging this Specimen ſufficient till the Proprietor of the *Mercator's-Chart* ſhall think fit to have it inſerted therein.

N. B. This Scale may be made to appear in various Forms, which I purpoſely take Notice of, leaſt *a certain Perſon* ſhould put it in another Dreſs, and call it his own, as he has of late made bold to do with the Scale in *Page* 20; of which I believe Mr. *Sturmy* to have been the firſt Inventor.

FINIS.